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ADHESIVES AGE

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Epoxy Bonding Cuts Typewriter Production Costs by $24,000

Schenectady Resins increase adhesion, control tack of shoe sole adhesives

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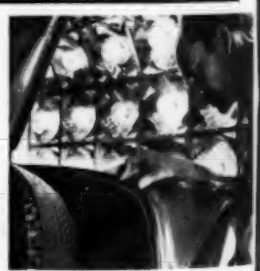

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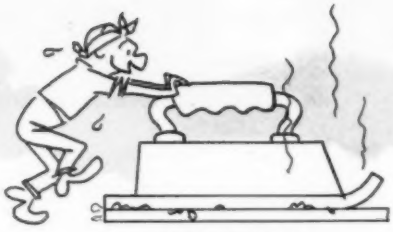

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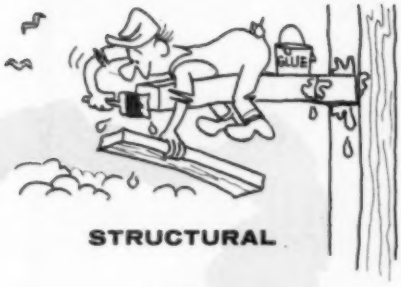

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Our current cover focuses attention on the article beginning on page 22 in which a new production development at Underwood Corporation is examined. The development of a new room-temperature curing epoxy, and some unique production-line dispensing equipment, cuts costs by eliminating various mechanical fastening operations. Experts from both the adhesives and typewriter firms involved tell how the setup was worked out.

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EDITORIAL

September and November

The intricacies of the publishing world are such that while this editorial is being written on a muggy Indian summer day, you will be reading it in brisk November. Science has long attempted to establish a relationship between weather and human emotions—and we accept the premise without further proof. It then behooves your editor to synthesize a certain briskness and anticipate that which will strike a proper editorial note on a crisp autumn day. What we are doing, in essence, is planning ahead. And by this circuitous route we get to the matter at hand—planning ahead.

We once heard planning defined in this way: When business does it—it is an intelligent appraisal of tomorrow's needs. When government does it—it's socialism. Whatever our political persuasions all of us do recognize that a certain amount of planning is a necessity in this changeable world. All of us, and that includes the adhesives industry, must give some thought to tomorrow and how we can best meet the demands which will likely be placed upon us.

Once we have established the need for planning we can attack our problem in one of two ways. In one case, we can arm ourselves with all the marketing and statistical information we can—extend our figures to some point in the future and plan to meet needs based upon these calculations. In the other approach, we begin to put into concrete thought certain "feelings" we have. This is known as the intuitive approach. Some of us may wish to combine approaches "A" and "B" and some of us may feel that this dilutes the "scientific" approach of A or the "mystic" approach to B.

There is still another way to approach this matter of planning. See what your competitors are doing and do the same thing (but add or substract a little so the plan is all yours).

As editors, we haven't any competition in the sense of adhesives manufacturing or marketing. So we can discount the last approach. Too, we recognize that statistical information on the adhesives industry is a little on the weak side. That eliminates "A." Utilizing the "B" approach, we have feelings about the adhesives industry which we would like to pass along—and it may be that our feelings will help you in your planning.

If we had to suggest three areas in which adhesives consumption should go up dramatically in the next three years we would say: (1) Bookbinding; (2) Building; (3) Automotive. Have you any plans in these areas?

If we had to suggest three forces which are having impact on the future of the adhesives industry we would point to: (1) Automation; (2) Prefabrication; (3) Research. What place have these forces in your plans?

If we had to suggest three factors which are at work in the adhesives marketing picture we would direct you to: (1) Imports; (2) Technical service; (3) Advertising. Where do you stand here? Are these factors major considerations in your plans?

From where we sit in September, we think you should be thinking about these things in November!

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Brass-to-Brass Bonds

Question: Kindly recommend to us where we might find a proper adhesive for bonding metal to metal, particularly brass to brass. Is it posible to bond items like small medals to tie clips, cuff links, etc. and have a bond equal to that obtainable with soldering?

Answer: The problem is so similar to the one following that its answer has been incorporated therein.

Q-199

Bonding Precious Metals

Question: We manufacture emblematic jewelry and frequently have occasion to bond karat gold to karat gold, karat gold to sterling silver, sterling silver to sterling silver, and gilding metal to rich low brass. Traditionally this has been done by soldering. However, there are a number of cogent reasons why cold bonding or bonding employing only a minimum of heat would be far preferable.

Answer: The desire to eliminate soldering, which may cause heat distortion discoloration and a host of other difficulties, is understandable. Adhesive joining may furthermore lower production costs. When two dissimilar metals are adhesive-bonded, there is no corrosive couple.

Epoxy resins have been very successful in adhering metals to one another. Many metallic surfaces, however, have a tendency to form oxides, especially at elevated temperatures. Some of these oxides, for example that of aluminum, actually increase the adhesion. Other oxides, such as that of copper, result in a weak adhesive joint.

The noble metals, which resist oxidation, are readily bonded by epoxy formulations. Silver to silver bonds have shown a tensile-shear strength of up to 2000 psi. Brass also can be bonded to itself without the prior etching usually recommended for copper surfaces. Other metals should perform as well, provided that none be heated after adhesion. A room-temperature curing epoxy-polyamide adhesive may be suitable.

A word on method of application. Very small quantities of adhesives will suffice. Since the epoxy formulation may be rather viscous, it might be best to dispense a solution of same with an eye dropper upon both metal surfaces, allowing the solvent to evaporate before mating the two parts.

Q-200

Ethyl Cellulose to Chipboard

Question: We manufacture a plastic drop leaf table edged with a plastic "T" molding made of ethyl cellulose. The core of the three-ply top is chipboard with a plastic laminate face and back. Where the molding comes out to the female part of the drop leaf knuckle joint a part of the mold stem is cut off leaving a bit flapping in the breeze.

We need some adhesive which will bond the "T" mold at this point. The adhesive must be quick drying, require a minimum of pressing time, have a long pot life, be gap filling and provide high strength.

Answer: The thermoplastic ethyl cellulose molding will adhere more readily to the chipboard core than to the thermoset resin of the laminate face and back. Ethyl cellulose, cellulose acetate-butyrate, or good old pyroxylin (nitrocellulose) should give a good bond between molding and chipboard; but adhesion between molding and the laminate may be inadequate.

Perhaps a hybrid resin such as polyvinyl butyral/phenolic is required. The phenolic resin should provide adhesion to the laminate, while the polyvinyl acetal makes a bond with the ethyl cellulose.

Q-202

Adhesive for Use Under Water

Question: We are looking for an adhesive or cement which would set under water and form a firm bond between glass, wood and mineral rock. The bond need be water resistant for only four to five days. After that it will be discarded.

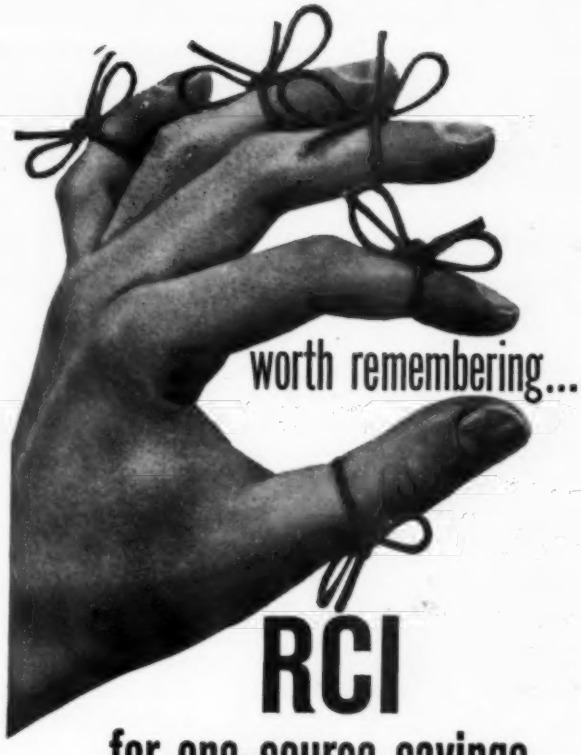
What product or formulation should we use?

Answer: The following solution by H. F. Wakefield, manager of Phenolic and Epoxy Adhesives for Union Carbide Plastics Company, may help.

"An adhesive is described in U.S. Patent 2,454,676 to Skow, Seiler, Oriani and Whitaker and assigned to the United States. It was developed in the Bakelite Laboratories under an Army contract, the object being to attach demolition bombs to underwater structures or boat hulls. The ingredients actually used were limed rosin, plasticizer 3 GH and asbestos."

Q-201

Dr. Irving Skeist is associated with Skeist Laboratories, Inc., 89 Lincoln Park, Newark 2, N. J. He is the author of the book "Epoxy Resins."



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PURE PHENOLIC RESINS Heat Reactive, Novolac Type, Thermoplastic and Terpene. A wide variety of resins intended primarily for tackifying and reinforcing neoprene, acrylonitrile and other synthetic elastomers.

PLASTICIZERS Polymeric and Chemical. A wide range of polymeric and monomeric plasticizers and epoxidized oils for the compounding of neoprenes, nitriles, and other synthetic elastomers.

CHEMICALS Phthalic anhydride, maleic anhydride, pentaerythritol, formaldehyde, methanol, phenol and phenol derivatives.

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One-to-One Adhesive

Formulated to allow equal part mix by volume without complications, Bondmaster M666, a high-strength industrial adhesive can be mixed without the use of scales. The adhesive is a two-component system which is mixed in equal parts by volume instead of odd ratios by

weight. Lower labor costs are expected to result from the ability of unskilled personnel to now handle room-temperature curing epoxy adhesive systems without fear of improper proportioning or mixing.

Bondmaster M666 Part "A" is colored red. Part "B" is clear amber. The user mixes the two until the striations of color disappear and a uniform tint is achieved. At that point, the adhesive is ready for use. Since the mixed adhesive is smoothly free-flowing, it may be applied with spatula, trowel, paint roller, knife, brush, or standard two-part epoxy spray equipment.

In application, the red color provides swift visual check on uniformity of coverage. Skipped spots or inadequately coated areas are instantly "signalled" and corrected. The adhesive is a 100 per cent undegraded epoxy adhesive which has been formulated for industrial use. It is reported to differ substantially from the conventional highly filled compounds or solvent-dispersed products currently being marketed for householder use.

Fully cured metal-to-metal bonds produced with this product, tested at room temperature, using MIL—A-5090B procedures, yield up to 3,500 psi. Bonds involving expanded styrene foam withstand 175 degrees F. for 200 hours without cell attack. Aside from the lower labor and equipment costs which are expected to result from the use of the mix, Bondmaster M666 is reported to be priced at 1/3 to 1/2 less than most conventional formulations of equivalent strength.

In mass production panel bonding applications, for example, the cost per square foot of completed glue line is equal to or less than that achieved with most solvent-dispersed "contact bond" types normally used for curtain wall and similar panel fabrication. In addition, since the formulated epoxy adhesive achieves strength at room temperature without the application of greater pressure than that necessary to keep components in intimate contact during the cure, the need for ovens, lamps, nip rolls, and similar capital equipment is said to be eliminated. The photograph shows how Bondmaster M666 may be applied by trowel. *Rubber & Asbestos Corp.*

P-554

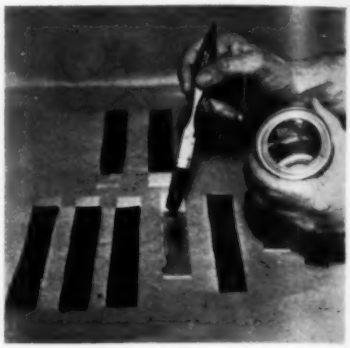
Mold Sipe Adhesive

Designed to withstand the high temperatures and pressures of the manufacture of trucks and passenger cars, Tygoweld 53 adhesive was developed for bonding sipes into tire molds. It is a two-part, 100 per cent solids adhesive that forms a strong bond to close tolerances by capillary flow. Because of its strength at high temperatures, it also has other mold applications such as resurfacing areas of steel, iron, cast iron, malleable iron or aluminum molds where breaks, dents or porosity have occurred. *United States Stoneware Co.*

P-555

High Solids Adhesive

CD Cement 350 is a general purpose adhesive used for bonding natural and synthetic rubber, vinyl plastic, fabric, leather, and wood to itself or to glass, steel, iron aluminum, phenolic plastic and many other surfaces. It is said to be permanently flexible. Fast setting and extremely tough, the product is



waterproof, exhibits good oil, gasoline and chemical resistance, and resistance to weather. The photograph depicts aluminum being bonded to rubber with the new adhesive. *Chemical Development Corp.*

P-556

Silver Filled Epoxy Adhesive

Designed to bond strongly to metal, glass, ceramic and most plastics, 2015, an epoxy silver filled conductive adhesive, is said to perform excellently where hot soldering is ruled impractical. In paste form, it is recommended for applications requiring low electrical resistance and good adhesive properties. Typical applications are lead terminals, printed circuits and shielding on bases. *Adhesive Engineering.*

P-557

Motor Repair Kits

Especially formulated for impregnation and sealing of motor windings, Permacel PRH-500 and PRH-510 are two-part epoxy systems consisting of a resin and a hardener. Improved moisture resistance and heat dissipation are said to result from impregnating coil windings with PRH-500. The system is recommended by the manufacturer for sealing and capping motor coil windings. *Permacel.*

P-558

hughson CHEMLOK® ADHESIVE DATA

UP-TO-DATE INFORMATION ON SPECIAL-PURPOSE ADHESIVES FOR INDUSTRY

WHY CHEMLOK ADHESIVES LEAD

From a standing start in 1956, Chemlok Adhesives have become the most widely used rubber-to-metal adhesives in the world. There are clear-cut reasons for this quick acceptance of Chemlok 220 and 203.

Only Chemlok Adhesives bond the entire spectrum of commercial elastomers. Only Chemlok Adhesives offer all these performance advantages:

Versatility: One adhesive system bonds natural rubber, GR-S, butyl, neoprene and Buna N to all metals and many rigid plastics.

Wide Manufacturing Tolerances: Bonding is simplified by the wide latitude permissible in compounding, surface preparation, adhesive application, metal parts handling and molding technique.

Environmental Resistance: Maximum resistance to heat, hot and cold water, salt spray, chemicals, oil, solvents and corrosive atmospheres is obtained by use of Chemlok 203 and 220.

One-Coat Application: A single coat of Chemlok 220 outperforms most conventional two-coat systems, and has equivalent environmental resistance.

HOW CHEMLOK ADHESIVES CAN SAVE YOU MONEY

coat — less adhesive, less labor, shorter cure time.

adhesive — avoids errors, simplifies inventory and application problems.

scrap — one firm cut scrap losses from poor bond to %!

processing — broad tolerances permit variations in elastomers, techniques, conditions.

NEW DEVELOPMENTS

Among the experimental adhesives now available for evaluation are:

- Adhesive EX-B150-1 permits heat bonding of dissimilar unvulcanized elastomers. It is the first to provide successful rubber-to-rubber bonds between elastomer combinations previously thought impossible to join, particularly where one is based on butyl. Typical applications include conveyor belt covers to bodies, wire and cable jackets to insulation, hose covers, roll covers and multilayer gloves.
- Adhesive EX-B579-1 bonds RTV (room temperature vulcanizing) silicone rubbers to metals, glass, ceramics, plastics and fabrics. One-part, one-coat, nonstaining adhesive provides bonding during the room temperature cure. It meets electronics industry standards, offers excellent environmental resistance to broad temperature conditions.

TECHNICAL LITERATURE

A letterhead request will bring you any of the following:

Technical Bulletin 2012 **"Chemlok Rubber-to-metal Adhesives"** presents comprehensive information on Chemlok 220 and 203.

Technical Bulletin 7101 **"Preparation of Substrates for Bonding"** is a valuable guide to proper surface preparation procedures.

"Some Fundamental Aspects of the Problem of Rubber-to-metal Adhesion" is the title of a technical article reprint which examines theoretical considerations in bonding.

Product bulletins and samples are available on all Chemlok Adhesives—standard, special, experimental. Please define your application area.

SPECIAL-PURPOSE PRODUCTS

Specialty Elastomer Adhesives: Silicone rubber, Viton A, Hypalon and other specialty elastomers are successfully bonded to metals, fabrics and other materials with Chemlok 607.

Surface Treatments: Chemlok Surface Treatments for aluminum are now available. Research is being conducted on Chemical Surface Treatments for metals to enhance their adhesion to organic materials.

Experimental Adhesives: Unique products are now being sampled or are under development which will create design opportunities now impractical because of inadequacy of existing adhesive products.

If you would like information regarding our progress in any of these fields, please write us.

hughson

HUGHSON CHEMICAL COMPANY
Division of Lord Manufacturing Company
Green Garden at 12th • Erie, Pennsylvania

Rubber-Resin Adhesive

An air-drying, synthetic, rubber-resin adhesive, Armstrong-D-218 will bond skin materials such as aluminum, galvanized steel, and porcelain enameled steel to many types of core materials, including paper honeycomb, tempered hardboard, cement asbestos board, insulation fiberboards, foamed glass and some foamed plastics. It has the static load and heat resistance, and the superior weathering and aging properties needed to serve these applications. The adhesive is suitable for either spray or brush application. *Armstrong Cork Co.* **P-559**

Front Seal Gum

Formulated without solvent, Flat Seal, a new front seal gum for all grades of envelope papers, does away with the need for ventilation systems. The adhesive may be used in existing gum boxes on all types of rotary envelope equipment. It is clean machining and performs without difficulty in inserting and metering machines, states the manufacturer. Drying may be accomplished by only low to medium heat. Flat Seal has high humidity resistance, and has satisfactorily passed 93 per cent relative humidity tests. *Morningstar-Paisley, Inc.* **P-560**

Vinyl-Backed Tape

A vinyl-backed, glass-reinforced strapping tape, Dutch Brand No. 400 is said to offer unusual abrasion and weather resistance, along with high tensile strength and adhesion. Dutch Brand No. 400 is designed for heavy-duty packaging, bundling, and palletizing under conditions of high abrasion. In addition, it will not deteriorate when stored in outdoor locations, the manufacturer states. *Dutch Brand Div., Johns-Manville.* **P-561**

FOR MORE INFORMATION on the new products described on this page use the Readers' Service Coupon on page 54.

Adhesive for Laminates

Fastbond 10 is a fast-drying, heat-resistant, high-strength contact adhesive for bonding decorative plastic laminates to plywood and particle board. A synthetic rubber based adhesive, Fastbond 10 is said to permit bonding of the laminate within 10 minutes after adhesive application under normal conditions of temperature and humidity. According to the manufacturer, Fastbond 10 requires only contact pressure, as achieved with a hand roller, to effect a high-strength bond. *Minnesota Mining & Manufacturing Co.* **P-562**

Self-Adhesive Index Tabs

Designed to provide a quick, neat system for indexing, Self-Adhesive Index Tabs are made of wear resistant and scuff-proof fabric material. They can be applied to most surfaces without moistening or need for glue, and simple fingertip pressure is said to assure permanent and complete adhesion to paper, plastic, and other materials. *Avery Label Co.* **P-563**

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Saves time and money on tough — and easy — jobs:

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• **Woodworking in Scotland.** Native pine and birch in the highlands and broadleaved trees in the lowlands formed the basis for the establishment of the woodworking industries in Scotland, but today much timber is imported from Scandinavian countries and Russia, so prosperous has that industry become. Among the products turned out in the area—which has recently come into prominence because of the nuclear submarines now stationed there by the United States—are composite board (plywood and wallboard) and chipboard. The expansion of this area as an industrial market has been well taken advantage of by one English producer of synthetic resins—around which, of course, the entire renaissance of timber construction has taken place.

Ciba reports that its office, opened in Glasgow as a branch in 1958, has since expanded for warehousing facilities as well. Chief customers of the firm in the area are the chipboard factories, the shipbuilding enterprises (where decorative laminates are used in large volume), and furniture manufacturers. Flush door and laminated timber producers also are in the area.

• **Aluminum in Epoxy Resins.** The English publication "Resin News" reports that with the development of polyester and epoxy type resins in the fabrication of press tools, foundry patterns and matched die molds, there is an increasing interest in the use of aluminum "wool" as a thermally conductive medium in conjunction with the resin. The two main functions in the use of aluminum wool in these applications are: (1) To dissipate the exothermic heat generated during the setting of the resin, particularly where thick sections are concerned, and (2) to render the final product as heat conductive as possible. This latter principle is used where molds and other equipment are required to be heated and/or cooled during their service life and thus requiring them to be heat conductive.

• **Exhibition Structure.** One of the by-products of industrial exhibitions is the occasional chance they give for designers to try out new or experimental structures for displays or buildings. Several years ago, for instance, the plastics industry in the United States co-operated in the planning of one of the buildings at a trade fair in Moscow. That one, a reinforced plastic structure originally conceived by George Nelson, the New York industrial designer, achieved wide publicity for its unique, tulip-garden effect, and for its wind-resistance in the face of Moscow storms.

From England, now, comes the report of a glued aluminum roof structure used on a temporary building at the International Union of Architect's Congress held several months ago on London's South Bank. Looking for all the world like a tent-camp, the roof is described as one of the lightest ever designed. The roof as a whole was composed of 108 pyramids, each eight feet square at the base and seven feet high. Construction was of aluminum sheet .036 inches thick, glued at the seams with an epoxy resin. Tests on a prototype of the pyramid component at Imperial College showed that the structure would take 2.53 tons compression load. Failure was by buckling, not at the seams.

• **Chemical and Petroleum Engineering Exhibition, London.** What is billed as the largest exhibition of chemical plant and oil refinery equipment ever held in Europe will take place in Olympia, London June 20-30, 1962. The exhibition, covering not only equipment but products, will include areas on resins, adhesives, paints, varnish, plastics, and man-made fibers, plus synthetic rubber.

Planning is being done through the joint sponsorship of the British Chemical Plant Manufacturer's Association and the Council of British Manufacturers of Petroleum Equipment. Additional information can be obtained from Engineering in Britain, 34 Victoria Street, London, S.W. 1, England.

• **Expansion in Italy.** Houdry Process Corp., Philadelphia, and Compagnia Internazionale Generale Industriale-Malatesta, S.p.A., have formed an equally-owned company, Montecassino, S.p.A. to manufacture polyurethane foam and foam products.

Acetone and phenol will be the main products from a petrochemical plant being built at Porto Torres, Sardinia, by the Italian firm, Societa Italiana Resine Gulf, (owned by Gulf Oil Co.) and Societa Italiana Resine, to go on stream in 1962.

Construction has also begun on three plants near recently discovered gas fields in Matera Province in southern Italy. Plastics plant is being built by Montecatini, and petrochemical plants by ANIC and Manifattura Ceramica Pozzi.

It might be pointed out that Italian chemical production has increased substantially over recent years. The jump was 19 per cent from 1958 to 1959, and in the period 1953 to 1959 chemical production

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On the Continent (cont'd)

more than doubled. Italy remains the fourth largest chemical producer in Western Europe, following West Germany, the United Kingdom, and France.

Typically, Italy imports more chemicals than it exports, but this deficit in the chemicals balance is being slowly reduced. Most of the chemicals she imports come from West Germany, the United States, United Kingdom, France and Switzerland. The biggest customer is Communist China, absorbing $23.5 million worth of chemicals, the equivalent of 10.6 per cent of Italy's total exports.

The Italian Association of Plastics estimates overall production in 1959 at a record level of 220,000 tons, a 32 per cent increase over 1958.

• **British Plastics Sales.** Sales of plastics in the second quarter of 1961 amounted to 158,200 long tons, topping by nearly 11,000 tons the previous record high. Sales were divided as follows: 103,300 long tons of thermoplastics and 55,000 tons of thermosetting materials. The rise in sales is partly attributed to higher exports and replacement of imports by British products.

Britain's involvement overseas and on the continent has become an object of much speculation since tentative plans for its participation in the European Common Market were announced recently. Other English commercial activity, however, is still evident. For instance:

Private investors are collaborating in a wide range of commercial ventures in Pakistan including paints, synthetic resins, and other plastics.

Imperial Chemical Industries, in its latest stockholder's report, stated that it now sells more to Red Bloc countries than to the United States. Management indicated that this large stake in both Western and Eastern Europe is bound to continue whether Britain joins the Common Market or not.

• **Wood Chipboard Makers Join British Plastics Group.** The young and expanding British chipboard industry has merged with the Wood Chipboard and Plastics Board group of the British Plastics Federation to "enable it more readily to achieve its aims than it could as an individual entity," in the words of the chairman of the new group.

The tie-in between the wood and plastics industry is a natural and historic one. Synthetic resin made the first really workable plywood feasible, and is intrinsic in manufacture of particle board, chip board and similar products. In addition, an important use of these materials is as support for both decorative and industrial plastics laminates. Here also, urea, melamine and phenolic have an important function, both as laminating resin and adhesive.

• **New Dunlop Patent.** Curing of rubber latex is the subject of a patent recently granted to the Dunlop Rubber Co. (London). It deals with a process whereby, without the use of heat, particles obtained have a greater strength than was possible with previous methods. The rubber latex is cured in the form of an aqueous dispersion by subjecting it to high energy radiation.

The irradiated latex can then be formed into shaped articles by conventional methods and allowed to dry. It is quite stable and can be used for the production of cured articles without the addition of sulfur or any other curing or vulcanizing agents.

The high energy radiation can be any form of radiation having an energy greater than 0.1 mega electron volts. This includes x-rays, gamma rays, accelerated electrons from linear accelerators or similar machines, beta rays, alpha rays, accelerated protons and deutrons, and neutrons produced in atomic piles or other sources.

• **Use of Curtain Walls Growing in Europe.** European architects have recently designed a number of buildings which are similar to our glass curtain wall skyscrapers. The use of curtain walls is growing and this is the reason the European adhesives industry is now producing a number of rubber sealants, as well as proper tools for their application. During the last German industrial fair in Hanover, companies exhibiting products for this market included: Baustoff-Chemie, Seebruck; Hagfa-Kittwerk Ewald Schenk, Hagen; Klebchemie GmbH, Ingolstadt-Ebenhausen; Odenwald-Chemie GmbH, Schoenau bei Heidelberg. The Boston Blacking Company GmbH, Oberursel, promoted its Prestik-Profile and Bostik-Sealant.

• **Adding Interest To Your Mailing Pieces.** Your catalog and other printed matter will be of greater interest if you add an attractive booklet, "Visitors Guide to New York," which is available free of charge in French, Spanish, Portuguese, Italian and German from the New York Convention and Visitors Bureau Inc., Pershing Square, 19 East 42nd Street, New York 17, N. Y. A cordial letter signed by Mayor Wagner, many pictures of important buildings and sections of New York, short descriptions of all points of interest and a subway map are included in the publication.

• **German Molded Pulp Unit.** What is claimed to be the most modern molded pulp operation ever constructed is going up in Western Germany. It is a $6.5 million unit being erected for Diamond National Corp., a major U.S. producer of molded pulp products which are used in packaging and paperboard. It is expected that the plant will be in operation in 1963.

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capitol cues

LAGGING CONSUMER BUYING IS CAUSING SOME CONCERN about the course of the business upturn. Economists in government and industry are basically optimistic. But the current recovery is now three quarters old and retail sales are still lackadaisical. So the experts are becoming a little jumpy.

Consumer buying plays a vital role in recoveries. It spurs industry to keep adding to inventory--the force that started the upturn. Also, rising spending makes businessmen feel that their existing plant is inadequate...and so it leads to expansion of capacity, a very dynamic plus for the economy.

THE CONSUMER WILL INCREASE HIS BUYING this quarter, in the view of many economists--if, indeed, the quickening hasn't already started. (It's usually a month before figures show any trend.) The experts are confident because income has been rising, consumers have built up backlogs of needs, and surveys suggest that confidence in the future is slowly being restored.

What if consumers disappoint and don't step up their buying? Then, analysts say, look for business to surge a bit later--after the year-end, rather than before. And they feel that this may be a healthy thing, spreading out the boom so that it lasts longer and doesn't finally finish with a big bust.

NO SHARP INCREASES IN CONSUMER PRICES ARE LIKELY during the rest of this year--and this stability may be an important factor in spurring retail sales. Big supplies and keen competition will generally prevail over rising wage costs. Looking further into the future, though, the prospect for 1962 is for some moderate increases in the indexes, as consumer demand goes up.

Here, by category, is what price economists see ahead--
-Food: Costs will be level until year-end, except for dips in meats. But get set for moderate increases during 1962.
-Apparel: Present stability will be followed by gradual hikes in 1962, as the impact of the new minimum wage hits.
-Autos: Strong initial demand, plus strike-depleted stocks, will limit discounting until Spring--meaning firm prices, even if Detroit has not raised plant prices on the whole.
-Appliances: Prices are expected to firm up some in coming months as the consumer finally increases his purchasing.
-Services: The brisk march of the past decade will continue, led by rent and the cost of medical care--mainly insurance.

THE STABILITY IN WHOLESALE PRICES IS ABOUT TO END, after three long and remarkable years. Government price specialists say that an upturn is inevitable, if the business recovery goes as generally forecast. The index, now 119% of the 1947-49 base, is likely to rise 3 points by end of 1962.

Farm products and processed foods will be lifted by cuts in acres planted and higher government crop-support prices. Among the industrials, there will be higher prices for such basic commodities as metals, textiles, pulp and paper, as well as for many kinds of machinery and production equipment.

Five leading experts report on significant new developments in organometallic research

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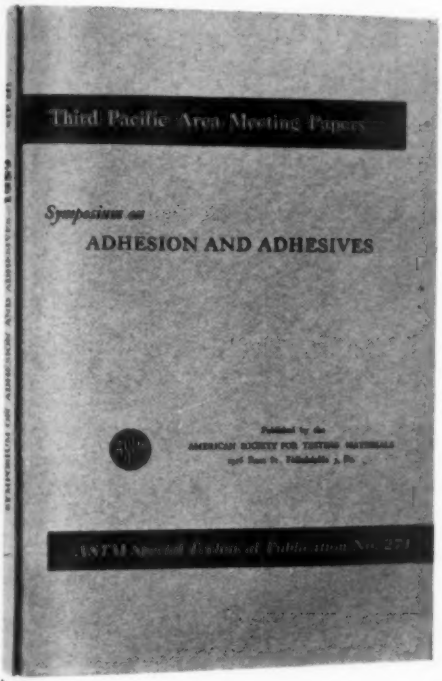

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This volume makes available in printed form material originally presented at the Third Pacific Area Meeting held by the American Society for Testing Materials at San Francisco in October, 1959. It also incorporates data and statistical analysis of a study undertaken to determine the effects of increases in the rate of loading on the strength properties of adhesives.

Although the volume is neither a complete nor an extensive study of the manifold problems relating to adhesives, it does answer some of the many questions of those engineers who have not used adhesives for metal applications and who, with additional encouragement, may incorporate adhesives in their designs.

The volume is a powerful impetus to the use, the technology, and the testing of all adhesives. Metal-to-metal adhesives, relative newcomers to the rapidly growing field of industrial adhesives, have grown in importance to such an extent that no designer can justify overlooking their advantages.

TABLE OF CONTENTS:

Lap Shear and Creep Testing of Metal-to-Metal Adhesive Bonds in Germany —By K. F. Hahn, Douglas Aircraft Co.

Elevated Temperature Resistant Metal-to-Metal Adhesives Derived from Organic-Inorganic Polymer Systems—By E. C. Janis, Narmco Industries, Inc.

Preliminary Evaluation of Ceramic Adhesives for Stainless Steel—By L. E. Gates and W. E. Lent, Hughes Aircraft Co.

Tensile Shear Strength of Adhesive Bonded Metals as a Function of the Rate of Loading—By D. A. George, John Mandel, National Bureau of Standards, and H. R. Butzlaff, A. O. Smith Corp.

Bonded Metal-to-Metal Shear Testing—By L. R. Lunsford, Convair Division, General Dynamics Corp.

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GET SET FOR TOUGHER PRESSURE FROM LABOR for ever-bigger benefits. Labor experts in Washington see the recent settlements in the auto industry as a breakthrough for unions generally--as setting new targets to shoot at. This may not be so important for the rest of 1961, when few major contracts come up for negotiation. But it will dominate labor relations during 1962.

> The item in the auto package that could mean headaches for employers in many other lines is the big step taken toward "salaries" for production workers. Hourly workers get paid for wages lost in short weeks. Aim is to force more even scheduling...to avoid layoffs...to give workers security.
>
> Other gains won by the union include 7¢ an hour in wages; expanded supplemental unemployment benefits; and assumption by management of the total cost of health-welfare insurance plans, part of which had, up to now, been borne by workers.

THERE'S DISAGREEMENT AS TO THE INFLATIONARY IMPLICATIONS of the auto settlement. It may not produce higher prices on 1962 cars. But economists fear that unions will be winning similar large benefits from companies that cannot afford to absorb the extra labor costs; they'll have to pass them on. Much depends on how many large companies will be hit--and for how much.

COSTS OF AMERICAN PRODUCERS AREN'T AS FAR OUT OF LINE with those of foreign firms as many believe. That's the conclusion that emerges from a recent study by the National Industrial Conference Board. It involved 100 companies with plants here and overseas. It showed that producers abroad do have lower costs on many articles--but not on all by any means. In fact, U. S. industry has lower unit costs on slightly more than half of the items compared. Labor costs us more, materials less. We produce more cheaply, over-all, than all areas of the world but West Europe, which has a 3% edge.

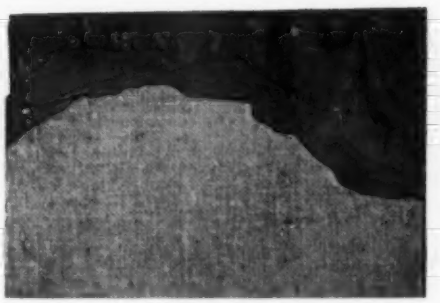
IF YOU ARE THINKING OF BUILDING A PLANT OR OFFICE, this could be as good a time to act as any you're going to see in the next year or two. For one thing, interest rates seem to have passed their cyclical lows; from now on, demand for money will grow and the supply will slip as folks save less. Building costs will firm, too, as wages keep rising and material costs climb with reviving demand; depressed lumber prices, for example, will rebound.

KENNEDY IS GOING ALL OUT TO COURT BUSINESS these days--a reversal of recent policy. His friendly meetings with business leaders are only first steps in his wooing campaign. The word is also going out to U.S. agencies to open the door to management men--to make them feel welcome and to listen to their views. It's not just because the President wants national unity in these days of international crisis. His economic advisers are worried that such things as his pressure on the steel-makers to hold the line on prices shake business confidence; such actions could choke off the business upturn.

> This doesn't mean that, say, the regulatory agencies will stop riding herd on business. They won't let up in their efforts to crack down on abuses or practices that restrain competition. But there'll be at least a lessening of the tendency toward sweeping, slashing policies of condemnation of whole industries. In short, the climate will change.

NEW RESIN MAKES NEOPRENE ADHESIVES TOUGHER...EASIER!

Laminated plastic panel forced from fir plywood by hammer and chisel 48 hours after cementing with formula including SHANCO #740. Note high percentage of wood grain failure compared with adhesion to plastic.



Strength of adhesion of formulated SHANCO #740 is greater than toughness of laminated plastic itself! Note destruction required to remove from plywood.

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Epoxy Bonding Cuts Costs of Typewriter Production

How Underwood expects to cut costs by some $24,000 annually by switching from soldering, brazing and welding to bonding with epoxy adhesives

By A. P. ALEXANDER
Allaco Products
Cambridge, Mass.

C. F. LANGENHAGEN, JR.
Allaco Products
Cambridge, Mass.

M. NIERENBERG
Underwood Corp.
Hartford, Conn.

At Underwood Corporation, Hartford, Conn., the substitution of epoxy bonding for soldering, brazing or welding in four different steps of typewriter production is expected to cut costs by some $24,000 annually.

Epoxy adhesives have been around for quite a while. They first made their presence known over a decade ago in the aircraft industry, and the use of epoxy adhesives with aluminum air foils is a well-known story. Since that time, tensile strengths have been improved, pot lives and cure times have been adjusted for a desired application, but no major breakthrough has been in evidence.

Allaco Products has developed Minit-Cure — an epoxy adhesive, that cures at room temperature in 60 seconds. This in itself is not revolutionary, but its use and method of application have opened an entirely new avenue for eliminating soldering, welding and brazing.

It is interesting to note that in perfecting this production line process, Underwood Corporation, one of the world's largest typewriter manufacturers and among New England's oldest firms, teamed up with one of New England's youngest companies — Allaco Products.

In essence, the production operation is quite simple. The parts of the typewriter that are to be bonded move along on a belt in holding fixtures. There is a pause beneath the nozzle of the metering and dispensing equipment and accurate amounts of adhesive are dispensed in the proper locations. The bonded pieces then pass through a bank of heating lamps (which accelerates cure to 45 seconds) and seconds later the entire operation is complete.

The epoxy dispensing equipment was designed by Automatic Process Control, New Jersey, to meter and dispense the epoxy in the proper ratios of resin and hardener at desired temperatures and quantities. The operator never touches or mixes the adhesive, and what had previously taken several minutes and separate drilling, pinning and soldering operations is now done automatically and chemically in less than a minute.

Specific Applications

Wayrod Assembly of Standard Underwood Typewriters. Brackets are fastened to the wayrod with Minit-Cure. This adhesive application has eliminated drilling, reaming and deburring four holes; a straightening operation; four dowel pins, and the dimpling of the brackets. The fixture to orient the brackets accurately with respect to the wayrod costs approximately $5000. The savings resulting from this change are expected to be $15,000 annually.

Platen End Caps of Standard and Electric Machines. A brazing operation is replaced with an adhesive application. This is essentially a hub pressed on to a knurled shaft and then brazed. In addition to savings of $1000 annually, there is the benefit of a vastly superior product. Brazing annealed the cold-rolled end cap shafts to one-half their original hardness. With the proposed adhesive method, the original hardness is retained. Yield strength after brazing is 35,000 psi. Yield strength using adhesive will remain at 70,000 psi.

Segment Guide Brackets on the Main Frame of Standard Machines. This assembly operation change includes substituting an epoxy adhesive for four locating pins and drilling four holes. Since the pins are designed to resist shear forces, this application is ideally suited for an epoxy adhesive. The savings resulting from this change are expected to be approximately $4500 annually.

Touch Tuning Bar of Standard Machines. A spot welding operation was replaced with an epoxy adhesive application eliminating a straightening operation caused by the welding. The adhesive is easily applied and cures in 30 minutes at 425° to 450°F. The

savings resulting from this change will approximate $3500 annually.

Future Use of Epoxies

Generally, consideration of the following factors determines the adequacy of an adhesive joint design:

(1) The adhesive joint should be in shear. Pure shear stress is most desirable. If the economics of the situation permit, techniques are available to convert tensile shear to shear stress with only minor design changes.

(2) The adhesive joint may be subject to vibration. It is possible to select epoxy adhesives which are highly resistant to shock.

(3) The adhesive joint must be of sufficient cross sectional area. It is desirable that the working load of an adhesive not exceed one-fourth the theoretical load capability in the adhesive application.

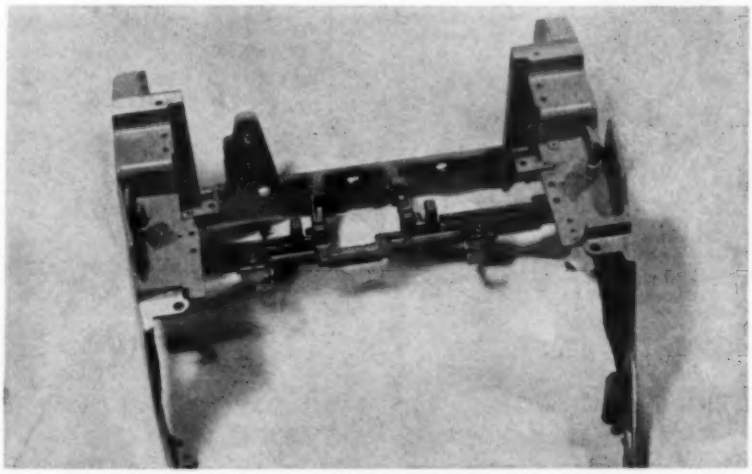
(4) The fixturing must be suitable. Since Minit-Cure cures at room temperature, and high molding pressures are not required, there is no evident distortion during the adhesive operation.

It is necessary, however, for the parts to be held rigidly during the cure cycle. Fixturing costs, with respect to curing cycle time and production rate requirements, must be prominent in the consideration of an adhesive application. An ideal design, from an adhesive application point of view, would be of parts which fixture themselves during the adhesive cure cycle. In adhesive applications, as in all design problems, compromises must be made with respect to design characteristics and choice of materials.

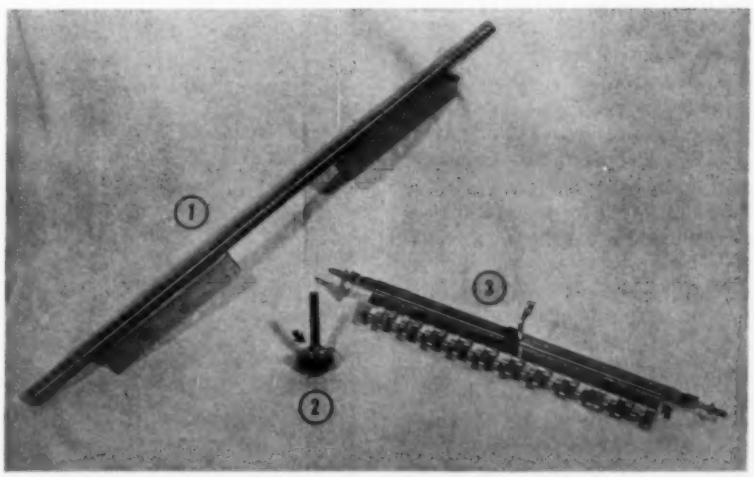
Estimate of Savings

With the continued exploitation of epoxy adhesive fastening, and increasing the scope to include the molding of some of the very resiliant epoxies, savings in excess of $50,000 annually can be realized by the Underwood Corporation. Several additional typewriter components including the type bar, bell crank spring plate, the type bar rest assembly and the spacer bar assembly would be of lower cost with the inclusion of epoxies.

In the production of the above typewriter, $24,000 has been saved annually by switching from mechanical fastening to epoxy bonding in four different operations.



The segment guide bracket on the main frame (see arrow) is bonded in position. This eliminates the time-consuming drilling of four holes and locating pins.



Three operations using epoxy bonding (see arrows). (1) Fastening brackets to wayrod. (2) Joining platen end cap to shaft. (3) Assembling touch tuning bar.

Bonded Honeycomb-Core Steel Doors

About the Authors . . .

Receiving his B.S. degree in chemistry in 1951 from Boston University, **Arthur Alexander** went on to take his M.S. degree in industrial management from M.I.T. in 1958. Prior to forming Allaco Products with Mr. Langenhagen in 1958, Mr. Alexander was assistant to the chief chemist at Metal Hydrides and director of research at Rocky Mt. Arsenal.

Mort Nierenberg has worked with and has been incorporating epoxy materials in products for the past five years. He points to this article as an indication of how engineering can successfully utilize technical advances.

In charge of production at Allaco Products, **C. F. Langenhagen, Jr.** received his B.S. in chemical engineering from Syracuse University in 1955. He received an M.S. degree in industrial management from the Massachusetts Institute of Technology in 1955. In 1958, he and co-author Alexander founded Allaco Products where Mr. Langenhagen is in charge of production.

The choice of an adhesive or epoxy application is subject to the success or failure of the part in various stress and life test procedures. Ease of handling in production is also a consideration in deciding whether or not a recommendation for change should be made.

Epoxy adhesives have made impressive progress; however, these adhesives also have limitations. Seldom can one adhesive be expected to perform a number of different tasks, and each application may require a slightly different formulation.

Until recently, formulators were limited by the number of different types of adhesive systems that could be compounded. However, the inability to formulate to meet particular requirements no longer is a block, and epoxies are limited only by the imagination of the user.

The production of honeycomb-core metal doors at The Steelcraft Manufacturing Company is sparked by an adhesive bonding technique. We use adhesive to hold the kraft cores firmly between two steel door panels.

The result, as demonstrated by a variety of rugged tests, is a much sturdier door with higher resistance to flexing and impact. Cellular cores not only serve as insulation but also deaden noise and do away with the hollow ringing sound typical of the usual metal door.

While the honeycomb-core method is well established in aircraft and other structural uses, this is believed to be its first application in the standard steel door field. Before we were able to get into this program, we spent several years experimenting with different types of adhesives, since we felt that the right type of adhesive was one of the most important parts of the product. This meant that we actually had to do the experimenting in our own plant with various samples. Different adhesive types were run on a production line basis for the purposes of testing and experimentation, before we settled on a formulation which met our standards and production requirements.

About the Author . . .

Werner M. Leeser, chief engineer of the Steelcraft Manufacturing Co., is a graduate of the University of Cincinnati. He is chairman of the Technical Committee of the Steel Door Institute.

Adhesive bonding of the honeycomb-core to the steel door panels is one of the most important steps in the building of the doors. A primary consideration for doors is exact evenness, and chemical fastening keeps the steel facings perfectly flat so that there is no buckling.

A highly desirable feature of the honeycomb-adhesive process in the Steelcraft doors is the absence of welded internal stiffeners which often cause surface-marring, heat-distorted areas. Tests have proved that, in spite of its simple construction, this new door is many times stronger than intermittent-girder types.

To keep pace with the door production rate of about one-a-minute, the door line in the plant has been modernized. Where there once was a lot of manual handling, most of the work now is moved on pallets and conveyors. In the Honeycomb-Core Department, adhesives are applied to the steel panel halves. Then the core material, a tough, cellular, kraft structure, is placed on one of the steel panels, constituting one-half of the hollow door. The second

By **WERNER M. LEESER**

The Steelcraft Mfg. Co.
Rossmoyne, Ohio

Adhesive-spread steel panels are placed over the honeycomb-core. Next, intermittent welds are made to hold the halves in alignment until the adhesive sets.

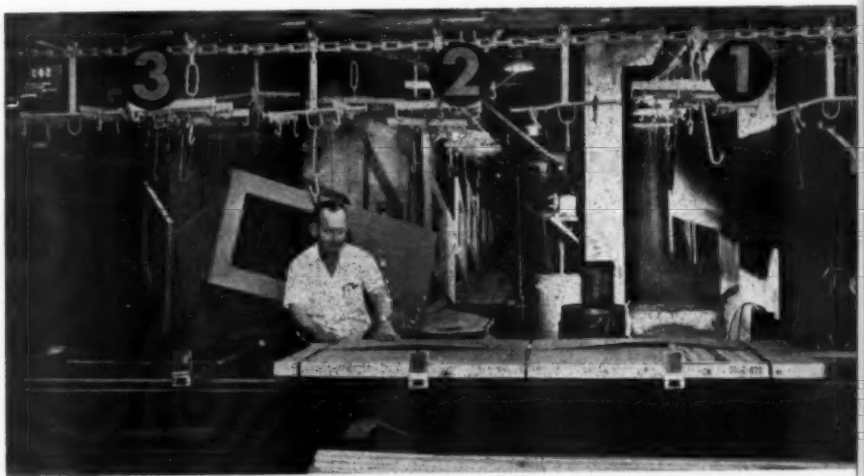
panel, lined with adhesive, is next set in place, and the sandwich of panels and honeycomb goes out to final assembly.

Assembled doors are inspected and edges ground smooth where necessary. Then they go through a five-stage bonderizing system and finally receive a baked-on prime coat of paint.

That the doors hold together and keep their shape has been proved in trials at Pittsburgh Testing Laboratories. For example, to check twisting, a door was suspended horizontally with three of its corners clamped securely to upright columns. Weights were then placed on the unsupported corner. With a load of 400 pounds, deflection was less than one-half inch. Permanent deformation after the weights were removed ran less than 3/32nds of an inch.

Once we had found the right adhesive, we were delighted to find that even after being subjected to severe abuse in many tests no delamination occurred and the core remained in position. In some cases this was true in spite of the fact that the door itself was taken to the failure point.

The honeycomb system is fast and flexible. This permits Steelcraft to offer architects design freedom in a wide range of low-cost standard items. It also makes possible doors and frames in many styles and sizes, with a variety of lights, louvers and other features.



(1) Doors first receive a corrosion-resistant paint base and then move through the paint line in center (2) and come out of the bake oven (3) for final packaging.

In twist test, the door is supported at three corners and as much as 400 pounds placed on unsupported corner.

In tests made at Steelcraft's Cincinnati plant, a trailer truck was run over an 18-gage steel door without damaging it.

Increased Water-Resistance with Silicate-Protein Adhesives

By ROBERT L. KREYLING

Philadelphia Quartz Company
Philadelphia, Penna.

A new silicate-vegetable protein adhesives system answers the need for economy and water-resistance in the handling and shipment of fiber containers

The similarity and chemical nature of carbon and silicon atoms have been recognized by their relative position in the periodic table. Much effort has been put forth, not only to secure reaction between silicate and organic substances, but also to produce silica chains such as silicones, organic silicates, and so forth, to avoid alkali and humidity problems.

Silicate - protein water - resistant adhesives first came to notice about 1917 when S. Butterman of Forest Products Laboratory developed a mixture of casein, lime and sodium silicate (U.S. Patent 1,291,396,-1919). At that time it was used in laminating wood for airplane propellers. For many years, the silicate-protein adhesives have been used practically exclusively in the production of water-resistant plywood, intended for interior service. Such plywood is widely used for cabinets, furniture, wall paneling and similar interior surfaces. It is not sufficiently waterproof for exterior use, but it has remarkably high resistance to disintegration on soaking.

Silicate-protein adhesives are applicable to surfaces other than plywood. The water-resistant quality has recently been found applicable to the fabrication of fiber containers. These adhesives have offered very good resistance to moisture under long exposure, high humidity conditions, and to 24 hour immersion.

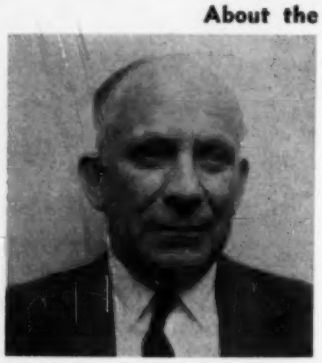
Vegetable proteins by their nature and reaction with other agents are suitable components for an adhesive system. This type of protein is largely globular and differs from fibrous protein in wools, casein, etc., which is frequently of a straight chain nature. The globular type of protein is considered as a moderate length chain, composed chiefly of monoamino acids and often includes peptide linkages (CO to NH).

Reacts with Protein

In developing the silicate-protein adhesives, the theory was advanced that silicates react with vegetable protein to produce moderate length amino-acids and polypeptides (U.S. Patents 2,681,290 and 2,894,847). Heat setting brings about cross-linkages with resulting molecular growth sufficient to produce water-resistant conglomerates. In the natural state, the chain is folded on itself and held together by hydrogen bonds between pairs of peptide linkages. In moderately alkaline conditions hydrolytic action will rupture some of the linkages, in other words, open up the protein molecule and the silicate micelles are then able to react with the various side groups exposed.

Under the influence of heat, the protein allows a reaction between the HO groups, which extend from the various molecular forms of sodium silicate, with the aldehyde

About the Author . . .

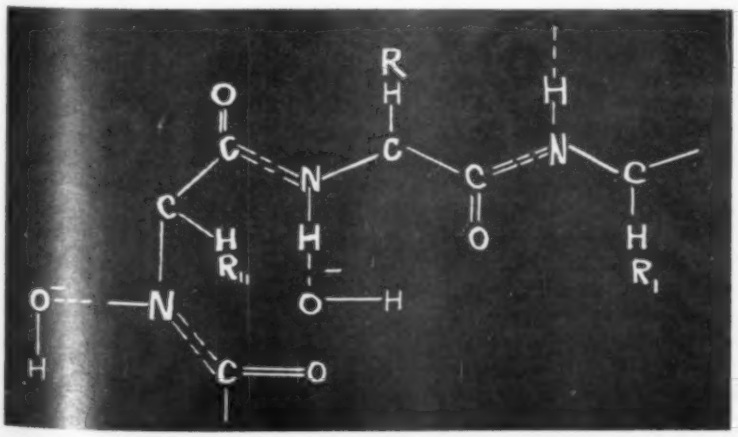


ROBERT L. KREYLING is currently manager of adhesives sales service at the Philadelphia Quartz Co. He is a member of the firm's Quarter Century Group. A graduate in chemical engineering from Washington University, St. Louis, Mo., where he received his B.S. degree, Mr. Kreyling also did graduate work in chemistry at the University of Illinois and at St. Louis University.

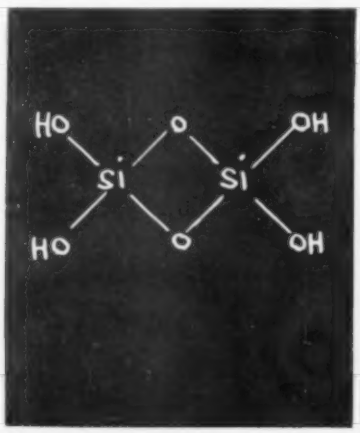
The above waterproof fiber boxes packed with poultry and ice withstood saturation and frosting for ten days. (Photograph courtesy of Crescent Box Corp.)

Waterproof fiber boxes withstand hydro-cooling and stacking.

Previously, silicate-protein adhesives were used exclusively in the production of water-resistant plywood intended for use in cabinets, wall paneling, furniture and similar indoor applications. Here, veneer sheets are fed through giant roller presses. (Photograph courtesy of Douglas Fir Plywood Association.)



This drawing illustrates the structure of the typical relaxed protein molecule.



Typical silicate micelles.

groups of the relaxed protein. The cross-linkages so formed result in formation of an insoluble waterproof bond.

In this manner, an interlaced mass is developed which effectively protects the precipitated condensate from further alkali or water attack. The reaction also reduces the alkali content of the adhesive to produce a final bond which does not have the susceptibility to water sometimes experienced with straight silicate adhesives.

Typical Formula

A typical formula which provides sufficient waterproofness to meet all PPP-B-636 requirements is as follows:

Soya protein*	14½ per cent
Pearl starch	3 per cent
Sodium silicate**	16 per cent
Water	66½ per cent

Test boards show satisfactory dry bond strength. Water immersion for 24 hours at 73°F. causes no voluntary ply separation. When re-dried, the original dry strength of the board is obtained. Boxes stored under high humidity show very small loss in bond strength.

The stacking strength of these boxes is high. For example, boxes which contained 900 pounds of poultry and ice withstood melting ice for ten days. Fruits and produce that are water cooled or top-iced are satisfactorily handled in these containers.

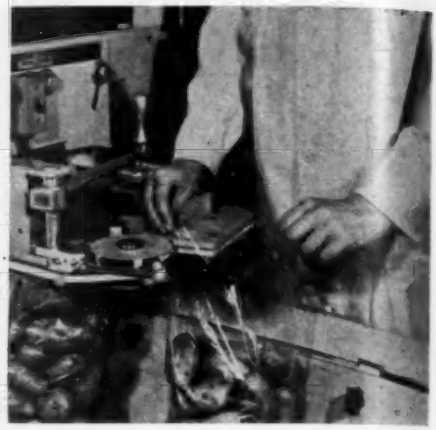
The new adhesive has answered the need for economical water-resistance protection during shipping.

Notes: * Purina protein, Ralston Purina Co. ** Stixso NN sodium silicate, 41°Baume, viscosity 180 centipoises, Philadelphia Quartz Co.

Problems • Problems

Have an adhesive problem? Been scouting for an answer? Why not try ADHESIVES AGE? Address our Consultant's Corner, ADHESIVES AGE, 101 West 31st Street, New York 1, N.Y. We will do our best to help.

To break the seal, the Y-shaped tab is simply pulled in opposite directions with the thumb and forefinger. The unit can be readily installed for either hand-fed or conveying line operations.



High-Speed Sealing of Polyethylene Bags

An automatic bag sealer designed to seal up to 80 bags per minute has been introduced by Minnesota Mining and Mfg. Co., St. Paul, Minn. Adaptable to all types of polyethylene bags—and to many cellophane and cloth bags—the machine features a unique device that adheres a special pressure-sensitive tape seal around the closure of the bags.

Called the Scotch brand S-605 Automatic Bag Sealer, the machine is designed for a wide variety of bagged products—oranges, apples, buns, potatoes, etc.—and can seal bags up to ten pounds in capacity. The taping head can be tilted at various angles to coincide with stationary or portable conveying machines.

Pressure-Sensitive Tape

The seal consists of a short, one-piece length of pressure-sensitive tape. If desired, a shorter length of paper may be simultaneously and automatically laminated to the tape during sealing to form a Y-shaped paper tab for easy breaking of the seal.

Rapid opening is accomplished when the tab, extending beyond the closure, is broken by being grasped by the thumb and forefinger of both hands and pulled in opposite directions. The tape can be quickly peeled back for opening.

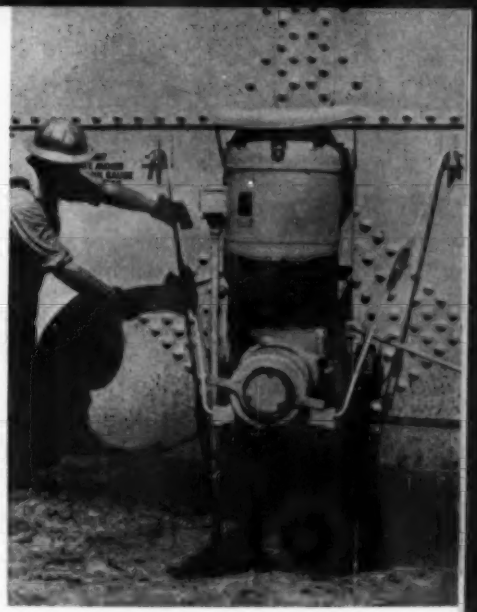
Various sized bags can be rapidly sealed without adjusting the machine. It is possible, for example, to seal three-, five- and ten-pound bags one after the other in a continuous smooth operation. Only slight adjustments are necessary for bag weights below three pounds.

Machine Capacities

The machine is designed for tape widths of from ⅜ of an inch to ½ an inch, and tape rolls up to nine inches in diameter. The length of each tape seal depends on the bag size and film caliper.

The speed of the machine depends on the bag size and whether hand-feeding or automatic conveying is used. Each bag is gathered instantly on reaching a gathering and taping mechanism. The tape seal is then applied, cut, buffed in place, and the sealed bag ejected from the machine.

The sealer is adaptable to most pressure-sensitive tapes. It can also be equipped with a special coding attachment in compliance with U.S. Department of Agriculture recommendations.



Steel plates are pressed into place, above, on epoxy-spread tank area. The next day, J-bars were attached and the bond strength permitted full support of the mixer, right.

Bonded Steel Plates Support 1250-Pound Load

Over six months ago adhesive bonding was used for the first time to attach mixer support plates to an in-service crude oil feed tank at the Shell Oil Company, Martinez, Calif. To date, the steel plates are still firmly bonded to the tank despite a continual load of 1250 pounds.

Use of a high-strength epoxy adhesive restored the tank to service in less than one day. To weld the plates, the tank would have had to be drained and purged, a process requiring at least six days downtime at an approximate cost of $2500.

The plate anchoring problem developed when a mixer had to be added without delay to the five million gallon tank. One end of the mixer was to be supported by a flange on the manhole cover—the other end had to be supported from the tank wall firmly enough to prevent mixer movement. A ground support was unsuitable because it could cause excessive propeller shaft deflection with subsequent leakage, overheated packings and shaft wear.

Two flat carbon steel plates (6 x 6 x ½-inch) were to be attached to the tank about eight feet from ground level. Steel J-bars would run from the eye holes in the plates to the mixer frame, with the slack taken up by turnbuckles.

Readying a crude tank for welding is an involved process, and possible only with elaborate precautions. A safe atmosphere must be provided to protect the welder and the tank. This can be handled in two ways:

(a) The entire tank can be drained, purged, and cleaned to eliminate the possibility of an explosive mixture. (b) The tank can be filled with water or high flash point oil with substantial loss of operating time. Neither of the foregoing procedures was feasible because of the limited downtime available in this case.

Bonding the plates was an alternative solution, but with a big question: Could any adhesive hold the steel plates to the steel wall permanently, and support a dead weight while resisting high peeling forces? Shell engineers thought it was worth finding out. If the method was successful, it would provide another tool for making structural attachments economically and quickly in the future.

On the basis of field and laboratory tests, Epon Adhesive 901/B-1 was selected to bond the plates. This solvent-free adhesive is produced by the Adhesives Department, Shell Chemical Company, Pittsburg, Calif. It bonds steel-to-steel with a tensile strength over 2800 psi; it is resistant to moisture, sunlight, climatic changes and most organic liquids; and it can be cured overnight at air temperature.

Installation of the mixer proceeded as follows: A time was selected when the tank level was below the manhole, the cover was removed and the mixer installed with temporary supports from the ground. The tank was then restored to normal service with a total operating time loss of about four hours. The bonding then took place while the tank was in service.

The mating metal surfaces were prepared for bonding by sandblasting to bright metal. The gray paste and liquid hardener were mixed together until the mixture turned red, indicating complete blending. A 1/16-inch layer of adhesive was spread with a putty knife onto the plates and the tank. The plates then were pressed against the tank and a fillet was formed around the edges. They were supported with jury-rigged blocks until the adhesive had set. The following day the adhesive bond was strong enough to take the full mixer load.

By E. PATRICK McGUIRE

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Packaging Adhesives and the Food Law

How does the new amendment to the Food, Drug and Cosmetics Act affect adhesives technology? How does it affect the adhesives manufacturer?

The amendment of the Food, Drug and Cosmetics Act in 1958 to include packaging materials produced a reaction among packagers akin to the passage of the Stamp Act during colonial times. This reaction was at times displayed in attitudes of frustration, anger, resignation, and ignorance. The passage of time has done much to clarify the requirements of the law and to explain the attitudes of the Food and Drug Administration towards its enforcement.

The purpose of this article is to examine the effects of the law on adhesive technology and to comment on those aspects of this legislation which bear special significance to the adhesive manufacturer.

The amendment to the Food, Drug and Cosmetic Act has one basic intent. This intent is *protection*. The law seeks to protect the consumer from any illness which might reasonably be caused by the presence of toxic food additives. The law now, in contrast to its pre-1958 attitude, regards the package and its materials of construction as capable of becoming a food additive and thus affecting the health of the public.

Upon reflection, this attitude is the only realistic approach possible. It would be folly to rigorously safeguard the contents of a food package and then contain it in a package capable of producing a toxic reaction.

The critical test for classifying a package or package component divides itself into two broad areas: whether the packaging material is inherently toxic by reason of its chemical composition, and whether or not this substance actually becomes a food additive regardless of its composition.

Possible Food Additive

The adhesive manufacturer must first accept the premise that his adhesive does face the possibility of becoming a food additive. Faced with this realization he then proceeds to eliminate those ingredients known to be toxic. And it is at this stage that his dilemma begins.

There is a wealth of information available regarding the safety of substances specifically designed for direct addition to food. No such abundance prevails when we enter the field of substances which were never designed or intended to be foodstuffs. The advent of the law has vastly increased the amount of pertinent knowledge, since it requires the submission of empirical evidence that these packaging materials, if ingested, will not prove deleterious to human health.

To produce such empirical evidence often requires a considerable time interval and substantial research. Basically, such data is obtained by reaction testing with animals. The method may involve intravenous injection of the material into an animal's bloodstream, intraperitoneal injection into an animal's abdominal cavity, or ingestion of the material in the drinking water or feed of the test animals. The duration of this test may involve months or years of feeding or observation. The life cycle of mice for example, runs to 1½ years.[1]

Additional concern has been expressed over the Delaney Amendment which prohibits the addition of carcinogenic substances to food or their use in packaging structures where migration is possible. Some critics of this amendment have claimed that the use of artificially high levels of dosage during the feeding tests has distorted the reactions obtained. They see these mass additions to the animal's diet as unrealistic and claim that the material being tested is not being fairly evaluated.

Other critics ask why cancer has been particularly selected to the exclusion of heart disease and other chronic illnesses. Nevertheless the language of the Delaney Amend-

ment is quite clear and the Food and Drug Administration is only taking those steps consistent with the enforcement of this amendment.

It has been specifically stated that "if component substances do not add (transfer or migrate) to the packaged food, the answer is simple and direct: such substances are not food additives as defined by the amendment."[2] The task for the adhesive manufacturer thus becomes one of determining whether the particular adhesive migrates out of a particular package into a particular food. This task is complicated by the need to determine correct methods for evaluating the migration or transfer of the adhesive into the foodstuffs. Ultimately we must be concerned with migration from the total package rather than from a single selected area.[3]

Adhesive manufacturers, such as The Borden Chemical Company, have conducted extraction studies and have sponsored extraction studies by university groups to provide further data on the nature of their adhesives with regard to migration or transfer. However, a standard body of extraction procedures which will lend uniformity and comparability to current research must be developed, since the test methodology employed can be of crucial significance. The absence of a sufficiently correct method of evaluation and extraction will provide sufficient grounds for refusing a petition to the Food and Drug Administration.[4]

Packaging materials, if ingested should not be harmful to health.

The adhesive manufacturers acting through the Adhesive Manufacturers Association of America have sought to establish those techniques of migration and abrasion testing which will prove of greatest value. The association filed a petition with the Food and Drug Administration covering the materials used in the production of adhesives to be employed for dry food packaging.[5] The Ingredients and Labeling Committee of the association has sponsored extraction tests on adhesives used in the packaging of liquid foods. Tests in this series have featured extractions employing water, three per cent acetic acid, hexane, etc. as extractable mediums. The data provided by such extraction studies will form the basis for further petitions and governmental clearance.

Besiege Producers

Once food companies became aware of their responsibilities under the amendment they immediately besieged the adhesive producer, the packager, the paper producer, etc. with requests for warranties or guarantees that the product they were receiving was safe and completely cleared under the new regulations. Such guarantees were often impossible to provide because the adhesive producer and his ingredient suppliers were still at the stage of inspection, testing, and petition.

These requests for guarantees were well intentioned, but they at times displayed an ignorance of the implications of the law. If the adhesive producer supplied a guarantee that the adhesive conformed to federal regulations, he was supplying a civil guarantee which may have aided in protection against civil suit. However, such a guarantee has been held to be valid only if the user has altered the product in no manner whatsoever.[6]

In the case of packaging adhesives the purchaser alters the product by the very fact that he employs it in an adhesive application. Despite this limitation it might be held that an implied warranty existed for the adhesive product. The general view has been that the primary responsibility for safety lies with the food packager who must be certain that the food he distributes has not become contaminated.[7]

This view is tempered somewhat by the response of the government as to the responsibility of the parties who are engaged in the total food packaging picture. Inquiries as to where the area of responsibility lies have been answered indicating that it was the responsibility of *all* parties to conform with the Food Additive Regulations.[8]

It has been noted that the basic difficulty with the guarantee situation has arisen out of the attempts of customers who wish to apply the laws and customs of the food industry verbatim to food packaging.[10] Some customers wish the guarantee to provide protection other than that intended by the law. Package component suppliers have been cautioned not to supply guarantees under this 1958 amendment because of the fact that such a warranty (although it may not have food and drug pertinence) may be construed to be an indemnity contract providing an express warranty to the customer regardless of the conditions of use to which he puts the product.[11]

The advent of the F&DA Amendment created some very real alterations in the development climate of packaging adhesive manufacturers. In order to fully understand this change we must first step backwards in time to the era immediately preceding the enactment of the amendment.

Streamlining of formulations is often beneficial.

Previously, adhesive compounders worked with a relatively free hand as far as the selection of formula ingredients was concerned. This is not to say that they were negligent and deliberately used formula components known to be toxic after migration from the adhesive film. Compounds known to be toxic were avoided by the vast majority of adhesive formulators.

But there was yet another area which we might term a grey area. In this area existed a vast number of formulary ingredients which were not specifically indicated as toxic but neither were they considered safe by recognized food authorities. As a matter of fact in most cases they were overlooked entirely.

In the individual opinions of the compounders these ingredients did not represent a health hazard. The point to remember is that at this juncture the compounder was often his own judge and jury. As previously mentioned, the responsibility for proving that this product combination was safe did not rest entirely on his shoulders, or at least he did not feel that the responsibility was solely his.

Faced with the need to use only approved formula components, the adhesive compounder at once retreated to a much smaller group of compounds. There have been a great variety of estimates as to the exact limitations thus imposed by the law. It would be my own personal appraisal that this change immediately cut off at least 30 per cent of the available adhesive compounding materials. It was not that all of this 30 per cent was actively toxic, but rather that the usage of these ingredients was not substantial enough to warrant the effort needed to effect their clearance. Therefore, the adhesive compounder replaced these materials with recognized ingredients more widely used.

It is important for us to recognize that adhesive compounding is a tremendously complex operation. A typical adhesive formula may be constituted from as many as twelve to fifteen ingredients, and an adhesive manufacturer may stock between one and two thousand such formulas. In many instances a formula is specifically designed to fit the needs of a single customer and perhaps a single machine. Following the enactment of the amendment, some adhesive formulas were discarded entirely and the search for a satisfactory substitute undertaken.

Some ingredients fall into a grey area which require attention.

From a developmental point of view, the first effect of the amendment was to restrict the number of ingredients available to the compounder. There was, however, a second effect which, in the writer's opinion, proved beneficial. The second effect referred to involved *standardization*.

As I have noted, adhesive compounding is complex. The individual chemist often increases the complexity of this operation by his ingredient selection process. It is not uncommon to find an adhesive formula with two, three, and sometimes four different types of defoamers, plasticizers, stabilizers, etc. present. Often, the benefit obtained by having this many ingredient types falls far short of the inventory cost involved.

Faced with a restricted number of ingredients, adhesives manufacturers overhauled and streamlined their formulas. Standardization upon a single type of ingredient addition took place. To the extent that standardization occurred, inventory investment, ordering costs, and even the unit price of the formula improved.

One point, however, should be made: There is a very real possibility that many adhesive substances which might ultimately come to fruition as good, safe adhesive bases will now, by reason of the research required for clearance, be buried along the path. Materials which represent only modest volume potentials will probably not be subjected to the extensive testing needed to assure clearance prior to use. It is however, too early to tell how seriously this limitation will handicap the known ingenuity of the adhesive compounder.

To illustrate the courses of action available in packaging adhesive development, let us examine the approach that The Borden Chemical Co. took to the problem of providing safe food packaging adhesives.

As early as 1950, Borden recognized that a concerted effort must be made to eliminate from consideration any ingredients of a packaging adhesive formulation which might prove to be deleterious if migrated to a food substance. The initial problem concerned adhesives for milk cartons but this effort was rapidly extended to all other food packaging adhesives. A series of staff conferences were organized to

About the Author . . .

E. PATRICK McGUIRE is the technical service manager for the Packaging Adhesives Group, The Borden Chemical Co. He was formerly a member of the research staffs of National Starch and Chemical Corp., and the Adhesives Products Division of Swift and Co. The duties of his present job includes the preparation and gathering of data for technical reports on company products.

make all members of the development team aware of the potential hazards in the use of borderline formulary ingredients. A systematic reappraisal of the entire formula list was conducted with a view to eliminating any ingredients of questionable nature.

Rather than rely entirely upon the opinion of company toxicologists, liaison was established with leading independent food laboratories to obtain their appraisal of adhesive formulas. During this stage, complete formulas were submitted to these independent laboratories and opinions were requested as to whether these adhesives could reasonably be considered a health hazard. The individual formula ingredients, as well as the combinations produced by these ingredients, were reviewed. The opinions received from these independent researchers was made available to Borden customers upon request.

A separate vein of inquiry was also undertaken which involved actual package migration studies to determine the extractive effect of various food substances upon packages and the package adhesive currently being employed.

Proceeding Backwards

Being a base producer of adhesive substances, as well as an adhesive compounder, allowed Borden Chemical to proceed backwards into the evolution of an adhesive substance and to eliminate objectionable elements before they appeared in a finished formulation. Thus, for example, it was possible to eliminate certain objectionable surfactants during the polymerization of the base adhesive substance.

It was also necessary to establish a close liaison with suppliers of formula ingredients not already cleared for use and to encourage these suppliers to actively "clean up" their materials in order that their use might be continued. Such inter-company cooperation is vitally needed in the search to provide the packaging industry with food-safe adhesives.

The short case history above is provided to illustrate the many fronted approach needed in the pursuit of a safe and sane packaging adhesive development effort. Other adhesive suppliers conducted similar programs for the purpose of insuring the safety of the adhesives they produce.

Much of the apprehension that this law would "return food packaging to the cracker barrel" has been ill founded. A great deal of this insecurity arose from misinformation and misunderstanding. The passage of time has allowed more level heads to prevail.

The Food and Drug Administration apparently now feels that much of the early hysteria is abating and being replaced by a business-like approach to the joint problems posed by this law. The net effect of this legislation has been to foster inter-company cooperation on the problems of food packaging to a degree which may well have been impossible under any lesser stimulus.

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(11) loc. cit.

Atomics International technician holds bonded slide in a glove box.

Ceramic-to-Glass Bonds in 60 Seconds

In a variety of experimental processes designed to determine the chemical reactions and textural inter-relations which occur during the firing of ceramics, Atomics International, a division of North American Aviation, Inc., has to bond ceramic specimens to glass slides. Conventional methods of cementing specimens — which are hard, brittle or of a very dense consistency—have proved inadequate since most adhesives do not have the necessary strength or rapid cold-setting properties.

Recently, researchers solved their problem with a polymerizing cyanoacrylate monomer. In preparing the slides, the ceramic specimens are polished to a smooth surface and cleaned with acetone. Then a drop of adhesive is placed on a slide and the specimen is positioned on edge, polished side down. One minute later the specimen is ready for further grinding operations.

The adhesive, Eastman 910, is a product of Eastman Chemical Products, Inc. It has a refractive index of 1.45 and a softening point of 165°C. An ounce is sufficient to prepare 100 slides.

By ROBERT BROOS
Manager
Industrial Adhesive Laboratory
H. B. Fuller Company
St. Paul, Minn.

Adhesive Technical Services Change an Art to a Science

Ten or fifteen years ago when a problem arose in bonding, virtually all accusing fingers were pointed at the adhesive as the "culprit." Today, most firms realize that "service problems" are as often caused by factors such as the gluing equipment, the material to be bonded, or the conditions under which the bonding is performed. The adhesive itself may be a contributing factor to the problem, but it is not always the basic problem itself.

That, at least is the consensus of opinion here in the H. B. Fuller Company's industrial adhesive laboratories. To these laboratories, every day brings new problems which mount understandably with the development of new kinds of machinery and equipment. However, looking back over the years we can see that while the technical problems are ever present, "service complaints" are diminishing with the growth of a broader understanding the requirements for adhesive bonding.

Technical men in the adhesive industry are well acquainted with all phases of production, including equipment, surfaces to be bonded or the adhesive itself. Consequently, customers think of us when a problem arises. Here's how it generally works:

The customer phones the adhesives company, understandably disturbed over the fact that the adhesive is not working to perfection. His production line is shut down, and will the adhesive company send a technician over with an adhesive that will make everything right again?

When we get a call of this nature at H. B. Fuller, one thing, and one thing only, is important to us: the customer has a problem and needs help quickly. For the moment it doesn't make any difference whether it is the fault of the adhesive, or there is actually trouble in some other phase of the operation.

Calls for help can often be handled readily over the telephone with a solution devised to either temporarily or permanently relieve the difficulty. However, in many instances the situation calls for personal, immediate attention by service experts in the Technical Service Department.

Usually, our people know from files and personal acquaintence with the customer what adhesive the firm has used and what the operation is. Quite often the man despatched may know the difficulty before he reaches the plant. However, major problems require careful, on-the-spot observation.

Most problems are usually comparatively simple to resolve *once they are known.* However, knowing what the problem is sometimes can be very difficult to determine.

Requests for technical service have changed considerably in the past ten to 15 years. This is due to several factors. One, customers have a better understanding of their own production techniques, and two. the adhesive industry has become more technical and scientific in the development of products. It is a rare case today when a customer says "the adhesive doesn't work." Generally, he wants a specific improvement in the efficiency of the adhesive. He wants a faster setting formulation, or a moisture-resistant bond, or some other specific advantage.

Not too long ago "glue was glue" and when anything went wrong with a bonding operation, it seemed logi-

About the Author . . .

ROBERT BROOS is the manager of H. B. Fuller Company's industrial adhesive laboratories in St. Paul, Minn. He has been with Fuller in various technical service capacities for the past 11 years. Mr. Broos has a BA degree in chemistry from Macalester College in St. Paul. He is a member of ASTM's Committee D-14 on Adhesives. His current Committee assignment is as section chairman of the special sub-committee on wood adhesives.

cal to blame the item which was supposed to be carrying out the end function of the machine. However, the tremendous growth of the packaging industry demanded from the adhesive industry new and improved adhesives to meet rising production, the new packaging materials, and the many modern units of gluing equipment being introduced.

In meeting the challenge, it was necessary for the adhesive industry to cautiously and steadily assume the role that can best be described as a science rather than an art. The formulator of today relies continuously on scientific information and data. New chemical theories of adhesion have permitted the development of new and better products.

In addition to these important factors, quality control and testing of adhesives to customers' specifications have been accelerated. This has resulted in adhesives firms having a vast storehouse of catalogued knowledge on raw materials and end results from which to draw upon for new work in the industry.

Due largely to this new growth in stature in the adhesives industry, today we find a greater spirit of cooperation between adhesives people and equipment manufacturers. This new, close liaison has made it possible to eliminate many problems. Adhesives are now recognized as primary factors in all packaging operations and great care is taken by the equipment manufacturer to design the application mechanism to get optimum performance from the adhesive.

Another factor contributing to the reduction in customer complaints is closer cooperation between the adhesives industry and suppliers of the various packaging materials. With new materials being placed on the market every day, it is desirable for the manufacturer of these materials to know whether or not they can be bonded. H. B. Fuller and many other adhesives firms work diligently with these companies in evaluating new packaging materials for adhesive performance.

As a result of this program, the manufacturer now has adhesives recommendations for the various packaging materials and the equipment they will be run on. By the same token, the supplier of the packaging materials has this information available and can recommend adhesives manufacturers who can supply formulations to bond his particular stock.

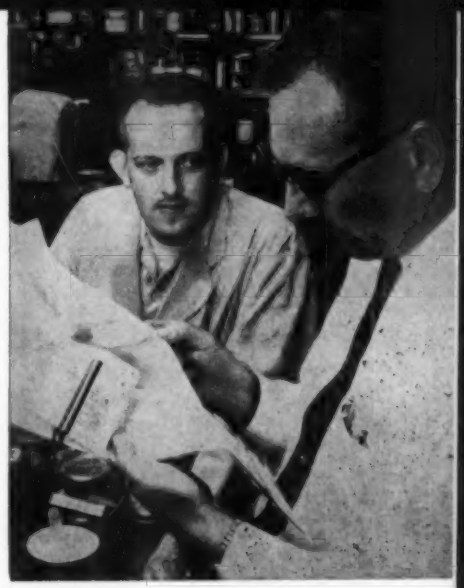
Until this kind of cooperation was achieved, it was not unusual for us to make a service call where someone was "having trouble with the glue," only to find that somewhere along the line the customer may have changed his packaging material. As new materials were made available, the customer would often take them into his plant and immediately run into difficulty because no adjustment had been made in the adhesive formulation.

As a result, he concluded that the adhesive was at fault since it "did not work" and it was up to our technical man to determine what the problem was. Since many materials and coatings appear to be similar, it was often difficult to tell if a change in stock had been made. However, as the technical service man efficiently and painstakingly began to isolate the various areas, the real troublemaker was spotted, and the customer was invariably quite surprised that a factor other than glue was causing the foulup in the machinery.

Bonding Newer Films

Many adhesives will handle a wide variety of stock. However, when you get into some of the special coatings that are being used today—some of the newer films that are available to the converter, for instance—the area of specific adhesion to these becomes quite important. Any change from one material to another may drastically affect the results of a bond. However, once the adhesives manufacturer knows that a change has been made, he can generally recommend a means of overcoming the difficulty and getting the customer's machinery back into profitable operation. Again, close liaison work between the adhesive industry and adherend suppliers has greatly eliminated problems of this type.

The responsibility of the technical service man, we feel, is threefold: first, to keep abreast of the industry; second, to be on the lookout for new materials and new products so that he can handle new situations as they develop; and, third, to be a super-sleuth in ferreting out the "real" problem in order that he may be in the best possible position to recommend the best adhesive for any given application.



Examining wax bag adhesive in Fuller lab are Orion Folland, chemist, and Author Broos, right. The adhesive was sent to customer for production evaluation and bags produced were returned to the lab for checking under many different conditions.

The adhesive industry is built on service. When a customer has to close down his production line because of a bonding problem, we immediately take steps to correct his situation. In other industries, service consists of repairs or of returning equipment to the maker for improvement. However, in the adhesives industry, technical service men go to the trouble of working closely with the customer to teach him how to obtain the most efficient bonding setup in the shortest possible time.

The converting and packaging fields require high speeds for profits. A shutdown, even for a short time, is costly. That's why almost all adhesive companies stress fast, skilled technical help for customers.

In performing this task, the technical man also plays another role—that of an educator for the adhesive industry. We train our technicians to instruct the converter and packager in the proper use of adhesives and help them understand the function of adhesives in the industry.

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How to Test Structural Adhesives

Adhesive bonding is now being used in highly demanding applications once thought impossible and testing methods have had to keep pace

During the past few years, adhesive bonding has rapidly expanded into many highly demanding commercial and military applications previously undreamed of, and adhesive testing has had to keep pace with it. Playing a major role in testing has been the American Society of Testing and Materials. For sixteen years, ASTM Committee D-14 on Adhesives has exerted a powerful influence in promoting wider use of adhesives by developing universally acceptable methods of testing adhesives and adhesive bonds. It has outlined gaps in present knowledge of adhesive properties, suggested approaches to fill these gaps, encouraged fundamental and engineering research on adhesives, initiated interlaboratory studies on new test methods, and fostered adhesives bonding symposia[1].

About two-and-one-half years ago, a West Coast Group of Subcommittee XI on Metal-to-Metal Adhesives was organized to assist this effort. Seven specific areas of interest to this subcommittee were selected for detailed study and these are at present in various stages of their adoption as standard ASTM test procedures. They are: (1) room temperature lap shear testing, (2) elevated temperature testing, (3) cryogenic temperature testing (4) creep testing, (5) compression shear testing, (6) peel testing, and (7) non-destructive testing.

Room Temperature Lap Shear Testing—The present standard lap shear test[2] has been in existence for over 12 years and has been adopted by the military services[3] for use in qualifying metal adhesives for structural applications. As its name suggests, this test utilizes a lap jointed specimen, Figure 1, which is used to measure the ultimate shear strength of a ½-inch long, one-inch wide adhesive bond by its resistance to a tensile load. This test has been widely used to qualify metal adhesives, determine the influence of various processing variables, evaluate the reduction of strength resulting from deteriorating environments, and, in general, to provide designers and engineers with usable data on which to base the design of their adhesively bonded structures.

A serious limitation of this test has been the non-uniformity of loading stresses and the poor reproducibility of ultimate values from specimen to specimen. This is due to the eccentricity of the specimen geometry. Based on some rather complicated mathematical and theoretical studies, Dr. Karl Hahn of Douglas Aircraft was able to suggest specific geometrical changes which considerably reduced this data scatter. These primarily involved increasing the length of the specimen under the grips to reduce

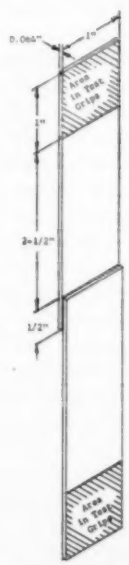


Figure 1—Lap shear test specimen.

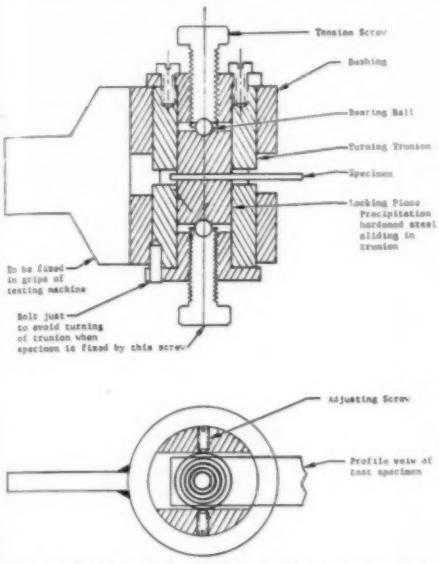


Figure 2—Special testing grips for lap shear specimens. They were designed to reduce the eccentricity of gripping.

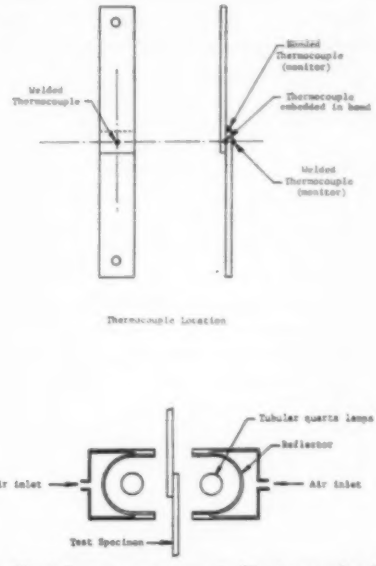


Figure 3—Heat lamp arrangement. Pin type grips hold the specimens in the testing machine so that loading is axial.

peeling and other variable stresses caused by superimposed bending loads.

A new type of test jaws, Figure 2, designed by Dr. Hahn has further served to reduce the eccentricity of gripping, and hence, test result scatter. In an extensive experimental comparison between several hundred specimens, the average data scatter, using the new specimen and jaws, was about a third of the former.

Elevated Temperature Testing—Because many missile and aircraft adhesive applications have involved very high temperature, a number of companies and laboratories have equipped themselves with facilities for simultaneously exposing and loading lap shear specimens to failure. However, the number of types of equipment, designed and used to simulate aerodynamic heating, has been so large that standardization has been difficult to achieve. For this reason, ASTM D-14 has investigated the present techniques and established a uniform and acceptable method[5].

According to this method, a carbon black coated lap shear specimen is uniformly heated in the bond area, by a tubular quartz lamp radiant source, Figure 3, to the required bondline temperature within a prescribed period of time. To obtain the desired heat flux, the quartz lamps are backed by a high efficiency reflector. Ends of the specimens are held in a testing machine by pin type grips so that the loading is axial and prevents heat drainage from the test area.

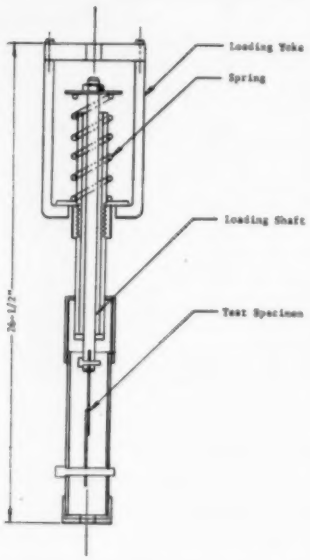
Temperature Calibration

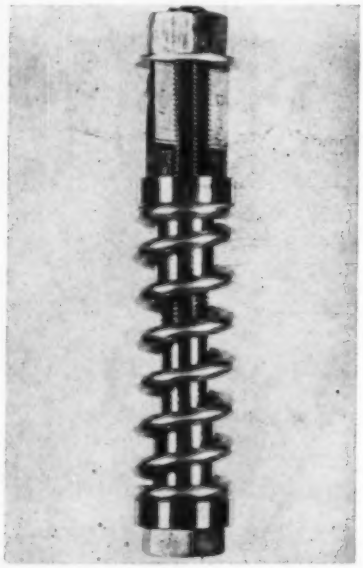
Prior to the test, temperature calibration is performed on a dummy specimen. Two thermocouples are used: one imbedded in the center of the bond and the other superimposed and bonded, or spot welded, to the outer surface. After the exact relationship between the two thermocouples on the dummy specimen has been calibrated, the same program is repeated on test specimens using only the outer thermocouple as a control.

Cryogenic Temperature Testing—In many space vehicles where cryogenic fluids such as liquid hydrogen or oxygen are employed, or where low temperature environments exist, any adhesive bonds present must be capable of withstanding the embrittling effects of these temperatures. However, testing of adhesive bonds at low temperatures can be an even more formidable challenge than testing them at elevated temperatures.

In most low temperature type testing, the specimen is chilled by being placed in an insulated container, which is filled with one of the cryogenic fluids. When it has reached the correct temperature it is pulled apart while immersed in the fluid. Although the test specimen and test procedure are not very different from those used at room temperature, the hazards of handling cryogenic fluids impose extensive safety precautions. Especially important are a good ventilating system, nonsparking equipment, and protective clothing on test personnel.

Creep Testing—In building or aircraft construction, where structural adhesive bonds are subjected to high loads for a considerable length of time, possible failure due to creep of the adhesive must be considered in the design. Creep machines have long been used by metallurgists for measuring creep of metals. These machines have also been used for creep testing of adhesives. Because these types are floor models consisting of a heavy steel frame, a cantilever loading device, and lead weights, creep testing of the more modest adhesive bond turned out to





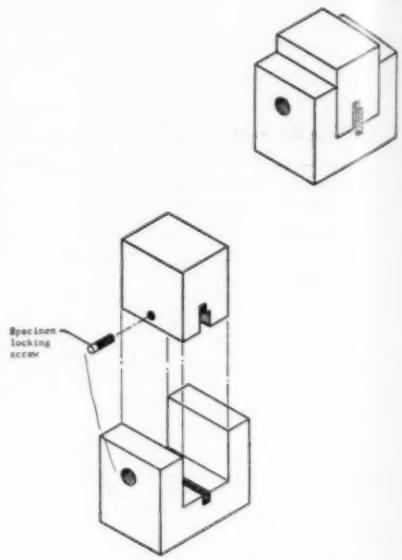


Figure 4 (left)—Tension spring creep tester. Floor models were cumbersome. Figure 5 (center)—Compression spring creep tester. Both use lap shear specimens. Figure 6 (right)—A compression shear testing jig guillotines specimen.

be a rather ponderous, inefficient affair.

A more satisfactory solution was achieved, however, when spring loaded devices were invented. Two such devices, introduced by the West Coast D-14 Group, are shown in Figures 4 and 5. Whereas the former utilizes a tension spring[6], the latter uses a compression spring[7]. In each case, however, the specimen is the familiar lap shear type, which tests the shear creep of the adhesive.

Calibrated Microscope

A simple, but accurate, method of measuring strain was devised. This method employs a calibrated microscope with stationary and movable hairlines that are aligned by eye upon the separation of a razor scratch across the polished edge of the bonded specimen. Elongations as small as 0.0001-inch can be detected and recorded. The test load is applied to the spring either by stretching or compressing it in a testing machine, or by employing its spring constant and measuring its change in length from its unstressed condition.

If the spring selected has a low spring constant relative to the type of adhesive being tested, the creep of the adhesive will not appreciably reduce the spring load. Furthermore, if high temperature spring steels are selected, these spring creep testers can also be employed for elevated temperature creep testing. Here, the measurement of strain is complicated somewhat, but is accomplished by the testing operator scratching the edge of the specimen with a razor at regular intervals while the specimen is in the oven, then at the end of the test, leisurely measuring their relative separation under a microscope.

Compression Shear Testing—The success obtained in getting identical creep properties from either the compression creep or tension creep test, led to the thought that perhaps testing lap shear bonds in compression rather than tension might have certain advantages. One simple example of such a test[8] is shown in Figure 6. Here a shortened version of the regular lap shear specimen is centered and aligned in the lower half of a compression shear jig, while the upper half is being forced to guillotine the specimen in two.

The principal advantage of the compression shear test over the tension shear test is that "pure" shear, devoid of any peeling load, is administered to the adhesive, with the result that much higher, and truer, ultimate shear property values are obtained. Other advantages are that the test specimen is simpler and less costly, strains as well as stresses can be determined, the test machine can be an ordinary accurate press rather than an expensive tensile tester, and, when failure begins to take place, there is much less stored elastic energy in the specimen ends and in the machine to influence the failure peak.

Peel Testing—Unlike shear and creep testing, which attempts to force the bonded faces to slide past each other until the adhesive fails, peel testing tears or cleaves the adhesive in a progressive fashion. Although such types of failures have not often been encountered in service, the peel test has received wide acceptance as a quality control test and is also useful for assessing the "toughness" or ductility of an adhesive. Whereas, originally a large number of different types of peel tests were used by different investigators[9 & 10], this number has now been reduced to two—the Climbing Drum Peel Test[11] and the T Peel Test[12].

Easier illustrated than described, the Climbing Drum Peel Test is shown in Figure 7. Here the drum is shown to be rotating and climbing upward under the action of a pair of tension straps wrapped around its flanges and being pulled downward by the head of a tensile tester. One half of the bonded specimen is flexible and is "peeled" away from the much stiffer other half, much in the same way that the lid of a coffee can is opened with its key.

Expressed as Torque

The magnitude of the resistance of the adhesive to this type of peeling is measured and recorded by the weighing mechanism of the testing machine and is expressed as a torque with units of inch pounds per inch width. Because the same climbing drum can be used to peel test a slightly modified bonded honeycomb sandwich panel, this test procedure has also been adopted by ASTM Committee C-19 on Structural Sandwich Construction. Simultaneously, it was incorporated into the latest adhesive military specification[13].

The T Peel Test derives its name from the geometrical form which the specimen assumes as it is being peeled, Figure 8. The material for this test is two strips of 0.032" 24 ST3 aluminum, measuring one inch by 12 inches with a one-inch by nine-inch adhesive bonded area. The three-inch unbonded ends are bent at right angles by hand and pulled in any standard tensile tester with autographic recording facilities, Figure 9.

After the failure has been started and a constant radius of curvature obtained, the load required to continue peeling remains fairly constant. T peel strength is defined as the average value of the peeling load curve, excluding the first and last portions of the test, and is expressed as a load in units of pounds per inch width.

The T Peel Test is not practical for brittle, low peel strength adhesives. This is not so much a reflection on the test as it is an expression of the fact that peel strength is a property that brittle adhesives do not have. If a peel test were to rate such adhesives favorably, it would not be a fair test. Many rubber-based adhesives are very brittle and notch sensitive at low temperatures. Their radical drop in peel strength is dramatically demonstrated with the T Peel Test.

Non-Destructive Testing—As in the case of other joining methods, such as spot welding or brazing, one of the most serious considerations in establishing the trustworthiness of an adhesive bond is the need for a dependable non-destructive test method. Some of the methods which have been explored by various investigators include tapping to detect variations in sound, transmission of heat by conduction, x-rays, radioactive tracer techniques, and ultrasonic equipment. Currently, the ultrasonic method appears to have made the greatest headway for use with organic adhesive bonding. There are two general ultrasonic methods for detecting substandard bond conditions:

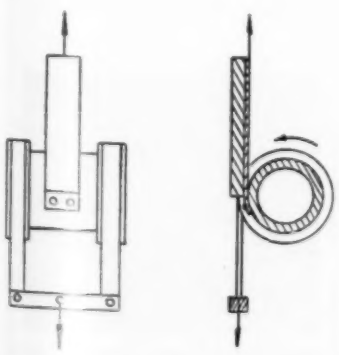
(1) Contact tests are made with resonance type equipment, such as the Stub Meter[14], Coindascope and the Fokker Bond Tester[15]. These units are lightweight and portable. They are not adaptable to high production work, but are good for spot checks and field service work.

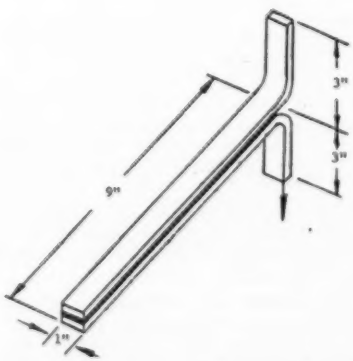
(2) For production work, conventional, pulse echo units such as Branson, Sperry and Curtiss-Wright units—used with automated fixturing and employing the immersion or water coupled methods combined with facsimile type recorders—provide considerable more data.

Reference Standard

With either the pulse echo or resonance methods, it is necessary to use some type of reference standard. This reference standard must incorporate closely-defined acceptance and rejection conditions. ASTM D-14 is planning to play an important role in standardizing such references and in recommending frequencies and techniques for ultrasonic inspection of adhesively-bonded materials.

Adhesive bonding of aircraft, missile, marine and space components has become a well established





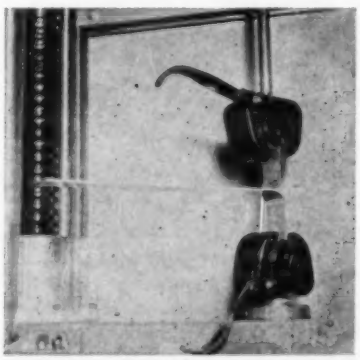


Figure 7 (left)—Climbing drum peel tester with drum rotating upward. Figure 8 (center)—T peel test specimen of two strips of 0.032-inch 24 ST3 aluminum. Figure 9 (right)—Specimen in a standard tensile tester.

industry, and new applications are continually developing. Problems which have already started to present themselves include those associated with bonding reinforced plastics to themselves, or to other materials such as metals, glasses, ceramics, or solid propellants. New adhesives are being developed which must be capable of withstanding higher loads, for longer times, under more extreme environments. In addition to ultra high and low temperatures, these environments include high vacuum, ultraviolet and x-rays, meteorite damage, attack by active fluids or fuels, high or continued rates of loading, and long time aging. Testing methods to evaluate adhesives under such conditions will have to be developed and standardized.

To maintain the necessary accelerated pace and to promote the desired exchange of ideas, it must be made possible for groups of directly involved engineers and chemists from universities, industry, and the government to work together. By promoting and encouraging such a local group on the West Coast, ASTM Committee D-14 on Adhesives has demonstrated its foresight and determination to solve these problems. By enthusiasm and present progress, this group has, in turn, demonstrated that such problems can be solved.

About the Author . . .

STEVEN YURENKA is the manager of the Engineering Research Department at Narmco and is responsible for the technical direction of exploratory structural analysis, materials applications, and testing activities for a number of military research programs.

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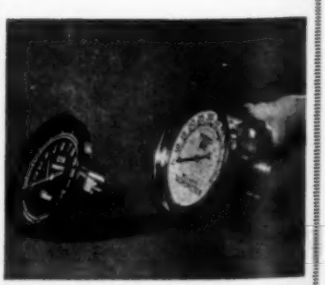
Assembly is made with screws (in trays) which have been treated in batches by tumbling them in the sealant.

Liquid-Locked Assemblies Cut Costs

Redesign of its Reliance tachometers to make full use of liquid-locked assemblies which reduce the need for friction fasteners has enabled Barbour Stockwell Instruments, Worcester, Mass., to cut production costs by 25 per cent.

In the new model of the Reliance, lockwashers and locknuts are eliminated, as well as several press fits. According to Barbour Stockwell officials the locking compound — a sealant designated as Loctite and manufactured by American Sealants Co., Hartford, Conn.—has reduced assembly time; cut fastener inventories; eliminated set screws; and retained gears, bushings, bearings, and screws.



Lightweight modern version of Reliance, left, compared with older model. Dial screws are also sealant locked.

NEWS of the

ADHESIVES WORLD

Structural Adhesives Symposium Held at Picatinny Arsenal

Some of the latest developments in modern adhesives technology were discussed at a symposium on "Adhesives for Structural Applications," held on September 27 and 28 at the Picatinny Arsenal, Dover, N.J. The two-day meeting, attended by over 200 design engineers of the Ordnance Corps and its contractors, was divided into four sessions at which 17 papers and a slide lecture were presented. M. J. Bodnar, chief of the Adhesives Research Unit at Picatinny Arsenal, planned the symposium, and W. J. Powers, deputy chief for research at the Arsenal's Plastics and Packaging Laboratory, served as general chairman.

Four Diversified Sessions

The first session, on "Design of Joints and Adherend Surface Preparation," emphasized such factors as selecting a geometry for the joint which will minimize stress on the adhesives, and stress the adhesive in the direction of its maximum strength. Specific surface preparations for adhesive bonding were also discussed.

The second session, on "Selection of Adhesives and Process Control," dealt with the selection of the proper adhesive and process control during the application of the adhesives and setting of the adhesive bonds. Also discussed was the importance of selecting an adhesive type which will withstand the environmental conditions anticipated and avoiding the pitfalls which may be encountered during adhesive bonding.

The third session, on "Special Applications for Adhesives," was devoted to the discussion of special applications of adhesives in ordnance end items, such as bonding reinforced plastics, and the use of adhesives in printed circuit applications.

The fourth and final session, on "Recent Developments in Adhesives," considered adhesives for high temperature service, as well as room temperature curing adhesives for structural applications. The future for structural adhesives was also discussed.

Four papers were presented at the first session. The first speaker, L. R. Lunsford (General Dynamics), in his paper "Design of Bonded Joints," stated that essentially, the entire surface of the USAF B-58 Hustler is aluminum bonded panel construction. He pointed out that primary as well as secondary structural bonded panels were designed and manufactured to operate in demanding service environments — high stress, sub zero temperature, high temperature, severe acoustical vibration, and with the requirement of smooth surfaces at subsonic and supersonic speeds. These requirements, he said, demanded that bonded joints in the B-58 be carefully designed and thoroughly evaluated.

Empirical Procedures Used

According to Mr. Lunsford, joints in the B-58 were designed by what may be called "empirical procedures," established for a specific adhesive system. Large numbers of test panels were required to confirm panel integrity and establish allowables for design. The speaker pointed out that the development and adoption of an accurate theoretical technique for predicting joint strengths has been pursued and can be expected to reduce the amount of testing and dollars required to achieve reliable design with adhesives.

"Joint Design for Primary Structures" was the subject discussed by the next speaker, Dr. Norman A. de Bruyne (Techne, England). Dr. de Bruyne described European use of glued construction for structural

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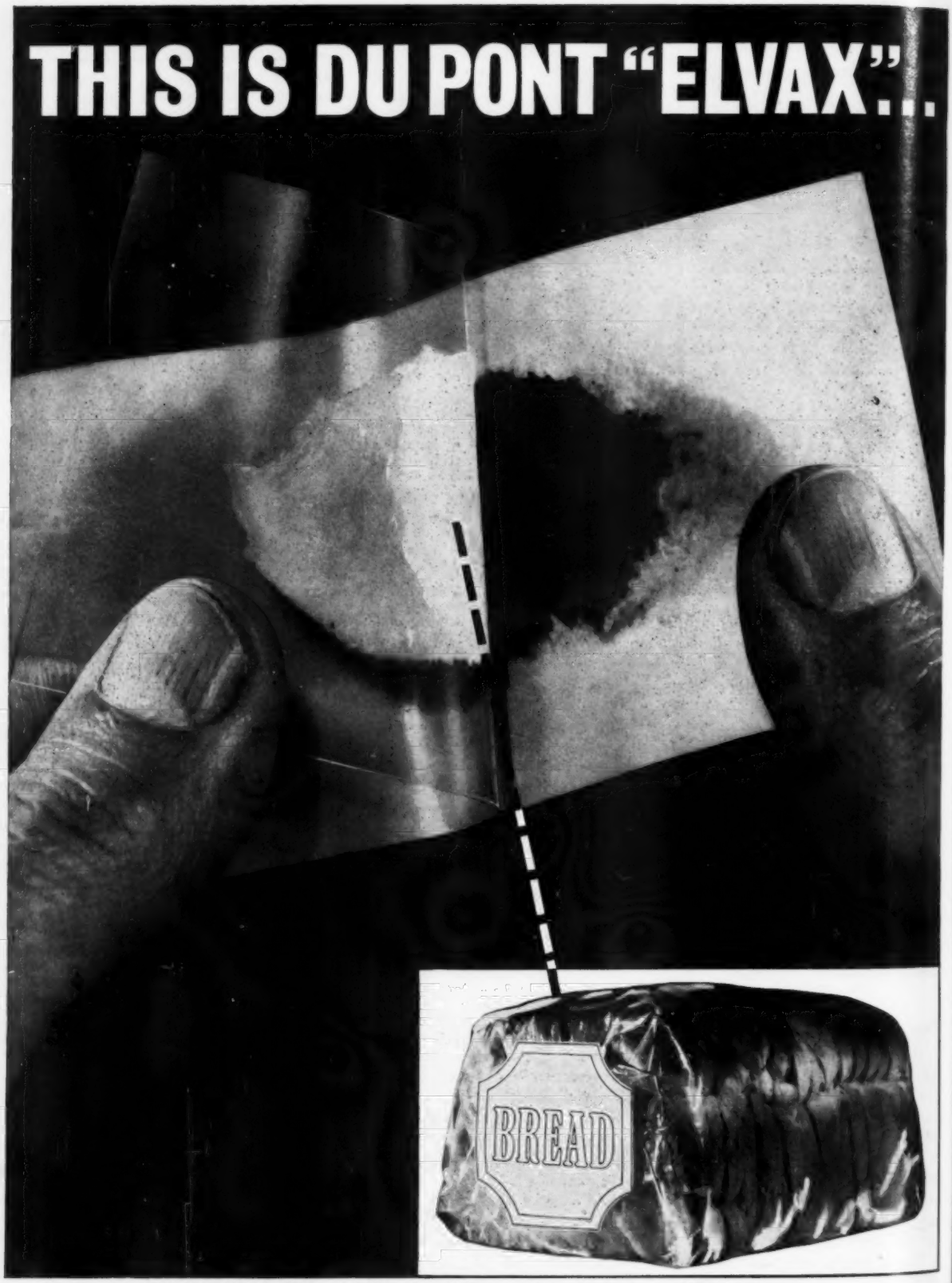

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

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VINYL RESINS

Participants in the Adhesives Symposium. Standing, left to right: William C. Tanner (Picatinny Arsenal), W. J. Powers (Picatinny Arsenal), A. A. Benderly (Diamond Ordnance Fuze Labs.), Edmund Thelen (Franklin Institute Labs.), L. R. Lunsford (General Dynamics), F. H. Bair (ASD, USAF), Harry E. Pebly (Picatinny Arsenal), Dr. Jack Dickstein (Borden Chemical), D. K. Rider (Bell Telephone Labs.), Dr. Norman A. de Bruyne (Techne, England), John B. Whitney (Boeing), D. F. Fouser (Douglas Aircraft), and M. J. Bodnar (Picatinny Arsenal). Kneeling, left to right, Charles H. Peterson (Hughson Chemical), Harold H. Levine (Narmco), Nicholas A. De Lollis (Sandia), Dr. Richard F. Blomquist (Forest Products Laboratory), Dr. Steven Yurenka (Narmco), Gerald Reinsmith (Ordnance Weapons Command), George Epstein (Aeronutronics), and Marco Petronio (Frankford Arsenal).

joints in aircraft. He discussed the important considerations in design and strength analysis of stiffened compression and shear panels, as well as aspects of detail design in bonded structures. Dr. de Bruyne covered bonded compression members, bonded shear members, fatigue strength, reinforcements, and applications.

He stated that with a suitable adhesive, two bonded sheets of metal can behave as a solid piece of their combined thickness with regard to buckling resistance. This is dependant upon the adhesive having both high strength and relatively high stiffness. According to Dr. de Bruyne, a bonded joint of the same overlap as a riveted one will show much better fatigue strength, perhaps nearly twice as good.

Bonded vs. Riveted Joints

Dr. de Bruyne pointed out that some people are misled by noting that the ratio of fatigue strength for a given endurance, to static strength, may be lower for the bonded than for a riveted joint. According to the speaker, this does not matter, because if a smaller overlap, by bonding, gives the same fatigue strength as the riveted joint, there is a weight saving. He pointed out that the fact that this bonded joint has a higher static strength is not a disadvantage.

Dr. Steven Yurenka (Narmco) in his paper on "Metal Adhesive Peel Testing" pointed out that employing the assumption that the adhesive bond behaves as an ideal homogeneous elastic material under load, the classical derivation of the deflection of a loaded beam on an elastic foundation is applied to the calculation of peel strength of a metal adhesive. This theory, he explained, results in a mathematical definition of peel strength and offers a reasonable explanation of the effects of the important variables such as metal and adhesive thickness and strength properties and provides a basis for the comparison and evaluation of the few testing methods presently in use.

Dr. Yurenka explained that when a bonded adhesive joint is gradually forced apart from the edges inward, the tearing which occurs is called peeling. Experience in the field and the laboratory has shown that an unbonded area in a bonded panel can become a localized source of failure which will progressively become enlarged when the panel is subjected to sufficiently high static or alternating loads.

Peel Test Valuable

According to the speaker, even if peeling type failures are not encountered in service, a suitable peel test is a valuable process inspection tool for producers and consumers of adhesive bonding. He stated that the usual approach in determining the peel strength of bonded panels has been to build a copy of a currently used peel testing machine and to amass a quantity of data with the purpose of establishing some arbitrary minimum value of acceptable peel strength for design or process control purposes.

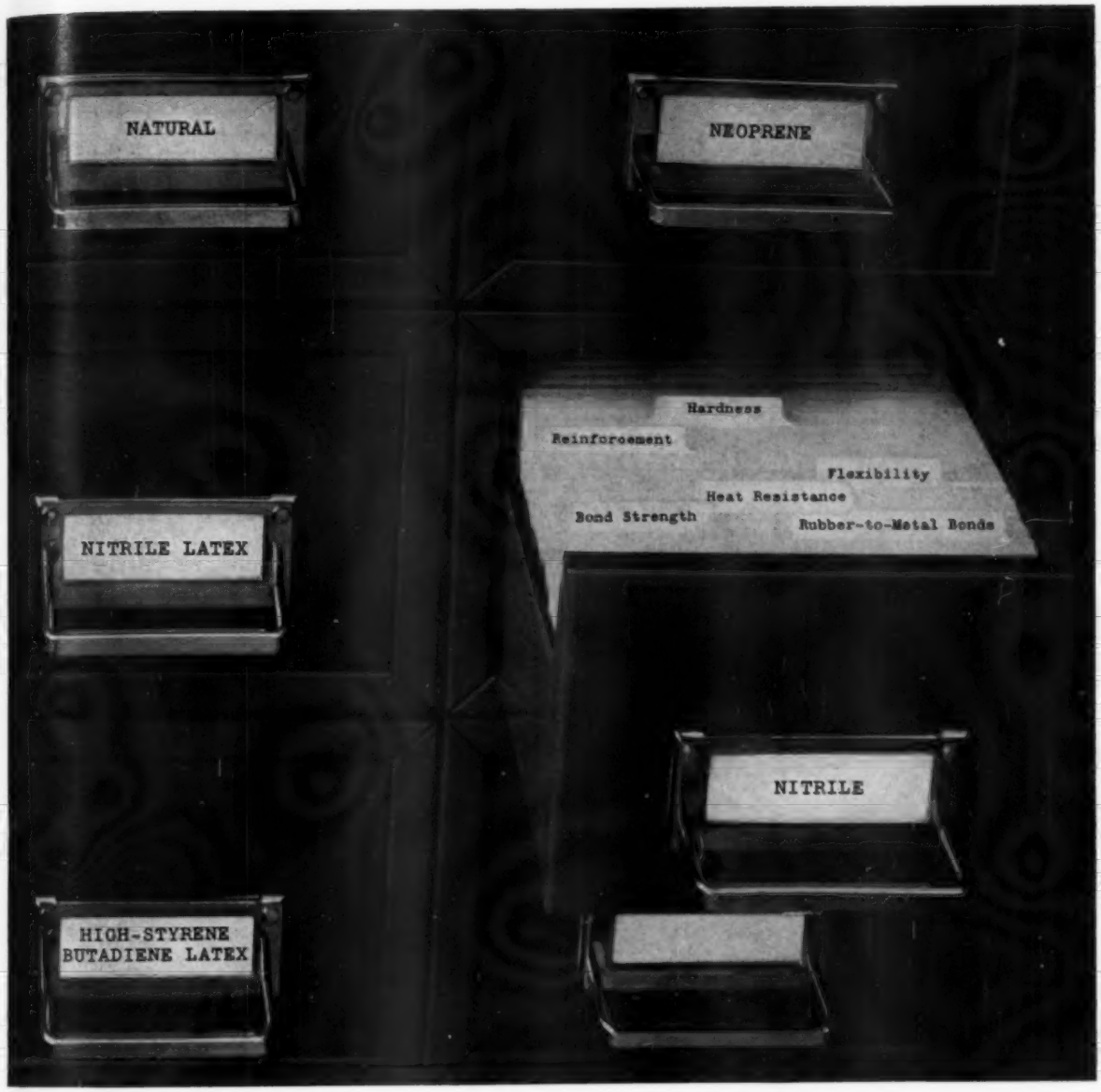
Ordinarily, he remarked, correlation between these results and those of other types of peel testers on the same materials is unsuccessful and the method is at best a qualitative comparison of a series of otherwise identical specimens.

Dr. Yurenka informed the group that, although more difficult, an ultimately more fruitful approach is first to investigate mathematically the nature of peel strength with the idea of arriving at a useful formula or theory and then to design a machine which will adequately control, test, and measure the important variables involved.

Determining Stress

"Methods for Determining Stress Distribution in Adherends" by K. F. Hahn and D. F. Fouser (Douglas Aircraft) was the final paper presented at the first session. The speaker, Mr. Fouser, stated that loading a lap joint in tension causes the adherends to increase their tensile stress over the nominal because of the bending produced by the offset of the joint. He pointed out that knowing the configuration of the joint, and the tensile stress, the stress distribution in the adherends outside the joint can be determined. The speaker explained that the theory, with resulting equations, is based on the assumption that the adherends act like a plate bent to a cylinderical surface.

According to Mr. Fouser, if the bending of the adherends is eliminated by the use of a double overlap joint, the stress distribution in the adhesive can be determined. He explained that this analysis is based on existing mathematical findings of the load distribution in rivets of riveted joints. The speaker pointed out that the resulting equations have been proven experimentally by the use of the PhotoStress technique, and can be applied to adhesively bonded, soldered, brazed, welded,



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M. J. Bodnar (Picatinny Arsenal), holding an adhesive bonded mounting plate assembly, explains its construction to, left to right, Paul S. Forsythe (Office Director Defense Research & Engineering Materials), Dr. J. L. Martin (Director, Ordnance Materials Research Office, and Col. D. F. Shepherd (Acting Commanding Officer, Picatinny Arsenal). At left, looking on, is W. J. Powers (Picatinny Arsenal), chairman of the Adhesives Symposium.

and under certain conditions, riveted joints.

The first speaker at the second session was Edmund Thelen (Franklin Institute Laboratories) who discussed "Adherend Surface Preparation." Mr. Thelen remarked that if an adhesive joint is to be strong and permanent its adherend surfaces must be treated at least to remove oil, dirt, and dust. In addition, control of surface roughness, oxide formations, and sometimes adsorbed water is required. Mr. Thelan pointed out that deposition of chromium atoms or TiO_2 is indicated for electron donor metals surfaces, and treatments may be useful to protect the adhesive from the adherend or vice versa, or to make their structures more congenial.

An Important Development

Nicholas De Lollis (Sandia), in his paper entitled "Structural Adhesives Characteristics and Application," stated that structural adhesives are one of the more important developments in the adhesive field because they make possible bonded assemblies in lightweight structures which take full advantage of the strengths of the materials used. He said that structural adhesives can be divided into two classes. One class consists of hard brittle resins typified by unmodified epoxy adhesives which have high shear and tensile strengths but low peel strength. The second class consists of a combination of resins resulting in a more ductile type of adhesive which has high peel strength along with high shear and tensile strength.

According to Mr. De Lollis, probably the most significant development in the field of adhesives is structural metal adhesives which have found such widespread use in the aircraft and missile industry. He explained that when used properly in lightweight structures, structural adhesives make possible bonded metal assemblies in which the metal is stressed beyond its elastic limit thereby achieving a 100 per cent bond. In other words, the use of a structural adhesive makes it possible to take advantage of the total strength of the metal. He described one application in which an epoxy adhesive is used in a design which minimizes peel forces and which causes failure of the bonded assembly in the metal.

The following speaker, Dr. Richard F. Blomquist (Forest Products Laboratory), spoke on "Importance of Evaluation of Adhesives for All Environmental Conditions and Permanence Studies." He stated that although considerable research has been conducted to establish the performance of various adhesives under different conditions of service, much remains to be done. He pointed out that of great importance are basic studies of the mechanisms of deterioration of adhesives in joints under known conditions, so that reliable short-term permanence tests may be devised to determine the expected performance of adhesives under various service conditions.

Tailored Polymers

According to Dr. Blomquist, new polymers can be tailored to provide a great variety of properties in adhesives, including high chemical stability and general resistance to bond deterioration under various service conditions. He pointed out that one of the major problems for both developers and prospective users of new types of adhesives, particularly for severe use conditions, is to determine the probable service life of the adhesive in joints. He would like to telescope many years of exposure into a few hours or days and yet be able to assume that his test conditions accurately duplicated use conditions. Dr. Blomquist felt that the development of accelerated permanence tests that duplicate in a short time the performance to be expected for periods of months or years still remains largely a dream, although some progress is being made. He pointed out that most experience on permanence of joints has been gained with wood.

Good Process Control

"Significance of Good Process Control" was the subject discussed by Floyd H. Bair (ASD, USAF). According to Mr. Bair, the important place that adhesive bonding of structural and non-structural parts has reached is largely due to the recognition and the practice of adequate and exacting processes necessary to produce acceptable parts. He stated that the procedures necessary for adhesive bonding are not common for all adhesives, adherends, or

parts being bonded. During any process, he explained, many variables occur that must be satisfied by the results of tests before production is started, and this must be followed by quality control tests to continuously assure that high qaulity parts are being produced.

Mr. Bair remarked that closely connected with processes are the temperment and capabilities of personnel doing the bonding. He recommended that a detailed procedure be established in order to develop methods for bonding any specific end item.

Attendees at the Picatinny Arsenal Adhesives Symposium examining a variety of adhesive bonded military components, which were on display during the two-day meeting.

Production Applications

The final paper in the second session, "Process Control in Production Applications" by William Bandaruk (Aeronutronic), was presented by George Epstein (Aeronutronic), and described a system by which adhesive bonding would be best applied to production on ordnance items. It was pointed out that in this system, process controls must be established. The author stressed that significant and meaningful process controls must be selected and utilized toward producing the quality and reliability expected of the ordnance article. He stated that the same adhesive material technology employed in advancing aerospace and aircraft concepts so effectively, can be profitably utilized in the production of ordnance items such as warhead and mines.

Use in Printed Circuits

The first paper of the third session was "Adhesives in Printed Circuit Applications" by D. K. Rider (Bell Telephone Laboratories). Mr. Rider discussed the technology of adhesives employed in printed circuitry. He described chemical types of adhesives and gave their general characteristics. Mr. Rider used typical printed circuit processes to spotlight the demands placed on the adhesives. According to the speaker, general adhesive requirements for use in printed circuitry should include: electrical properties equivalent to the insulating base; good bond to copper and to laminated thermoset plastic; retention of bond in both process and service; no corrosion of copper or other metals; and no harmful volatiles.

Mr. Rider stated that for purposes of copper-cladding printed circuit boards, there are three major types of thermosetting adhesives used in commercial practice—vinyl-modified phenolics, acrylonitrile rubber-modified phenolics, and modified epoxies.

Bonding Rubber

The next speaker, Charles H. Peterson (Hughson Chemical), spoke on "Special Adhesives for Rubber Bonding," discussing special adhesives for bonding unvulcanized and vulcanized elastomers. Mr. Peterson stated that available organic polymer based adhesives will produce high strength bonds to a wide variety of unvulcanized olefinic elastomers. He pointed out that a single coat adhesive has been developed which provides maximum performance adhesive bonds to a variety of elastomers.

He explained that the bonding of vulcanized elastomers is a more difficult task. According to Mr. Peterson, present adhesives require mechanical or chemical modification of the surface of the elastomer. He pointed out that "brute force" tactics used in conjunction with epoxy-polyamide, phenolic-polyvinyl formaldehyde, or nitrile-phenolic systems have performed well in some applications. The quality of these bonds, however, does not equal those produced to unvulcanized elastomers. He stated that, with the cooperation of the adhesive users, the adhesive suppliers are developing newer, more effective products to meet the challenge of the advanced polymers and increasingly severe environments in which they are used.

"Treating of Teflon to Promote Bondability" was the topic of the paper presented by the final speaker at the third session, A. A. Benderly (Diamond Ordnance Fuze Laboratories). Mr. Benderly reviewed various methods whereby Teflon and other poly-fluorocarbon resins can be surface-treated in order to enhance their bondability with ordinary adhesives. He pointed out that the treatment of Teflon, with virtually no resultant change of color, can be accomplished by radiation-grafting or by coating with a titinate polymer that has perfluorinated side chains. Corona bombardment, without resultant change in color, is applicable to Teflon-FEP copolymer only.

System Described

Mr. Benderly placed particular emphasis on the sodium-naphthalene-tetrahydrofuran treatment system. He stated that this system offers the advantages of versatility in the treatment of complex shapes of FEP and ordinary Teflon, as well as of Kel-F. Mr. Benderly pointed out that the bath can be stored and used intermittently without exhaust hoods or inert atmospheres, and no high-

temperature afterbake is required. According to the speaker, the bond strengths are at least as great as those resulting from any other treatment.

High Temperature Adhesives

The first paper at the fourth and final session was "Recent Development in High Temperature Adhesives" by Harold H. Levine (Narmco). Mr. Levine remarked that the prognosis for adhesives useful up to an hour at 1000°F. in air, is good. In addition, organic adhesives based on phenolic and silicone-phenolic resins are more capable, than expected, of usefulness at 1000°F. He pointed out that the preparation of semi-organic adhesives by reaction of heat stable organic polymers with inorganic reagents is feasible, and the prospect appears excellent for the achievement of adhesives to be used for 1000 hours at 500°F. in air, on steel.

According to Mr. Levine, despite research on 2000°F. adhesives, effort is still urgently needed on materials for use at lower temperatures. He stated that perhaps the area with the most serious shortage of information and research is the development and testing of adhesives for use at 180° to 500°F. for periods of three to five years. He explained that both military and civilian agencies are planning the construction of supersonic transports which need such structural adhesives.

Ceramic Adhesives

The following speaker, John B. Whitney (Boeing), discussed the subject of "High Temperature Ceramic Adhesives." He described the preparation, application, maturing, and fired properties of ceramic adhesives. He explained that the great majority of ceramic adhesives are based on glass-type bond similar to that found in porcelain enamels and ceramic coatings. The speaker pointed out that by using a frit as the basic constituent, the adhesives are applied to clean metal surfaces and fired to produce the bond. The adhesives resulting from this process retain a useful strength at temperatures of 1000°F. or higher.

Mr. Whitney also described a process for combining ceramic adhesives and brazing alloys. He explained that this combination has produced joints superior in strength to straight ceramic adhesives and comparable in strength to standard brazed specimens.

Dr. Norman A. de Bruyne, on left, discusses the paper he presented at the Adhesives Symposium, with Bernard M. Berns, ADHESIVES AGE News Editor.

RTC Adhesives

In his paper on "Room Temperature Curing Adhesives for Structures," Dr. Jack Dickstein (Borden Chemical) covered methods by which synthetic adhesives can be cured at ambient temperatures. He stated that alkyl cyanoacrylates, epoxies, and MPL monomers can be cured, with little shrinkage, to obtain metal adhesive bonds which compare favorably to those obtained by high temperature modes of curing. He explained that in order for an adhesive which is cured at room temperature to meet certain requirements, it must originally be present as a liquid in either the monomeric form or as a low polymer. The speaker described an investigation by which novolac epoxies were rendered more flexible with accompanying increases in the temperature and salt spray resistance.

Future Potential

"Potential of Adhesives for the Future" was the title of the paper presented by George Epstein (Aeronutronic). Mr. Epstein remarked that rapid technological advancements have contributed to the increasing application of adhesives. He stated that requirements for the future impose a severe challenge on our developmental capabilities, and more severe structural requirements and environmental conditions may be expected.

Complexity and Costs

He added that because of increasing complexity and costs, there are requirements for significantly higher orders of reliability and lower fabrication costs. In addition, improvements in bonding processes and development of comparatively new techniques, are desirable. He stressed that test methods require further development and standardization—especially non-destructive testing methods.

Mr. Epstein pointed out that continuing work in collecting and reporting pertinent information, especially on properties and design parameters for adhesive bonding, is helping to advance the utilization of adhesives. He informed the group that current trends indicate that adhesives are progressing from the realm of "art" to science, a factor which should substantially aid in advancing the future potential for adhesives.

The final paper of the fourth session was "Adhesives in Ordnance Applications" by William C. Tanner (Picatinny). Mr. Tanner discussed the advantages to be derived from the use of structural adhesives, and cited specific developments to illustrate the effectiveness of adhesives in Ordnance materials. He also discussed problems peculiar to Ordnance applications. Mr. Tanner compared the strengths of adhesive bonds as determined by "static" and "dynamic" conditions, and illustrated the importance of proper joint geometry.

Slide Lecture

Following the final paper, L. R. Lunsford (General Dynamics) presented a slide lecture entitled "Adhesives in Production Applications." The slides graphically showed the use of adhesives applications on the B-58 Hustler jet aircraft. The two-day adhesives symposium adjourned following a summation and general discussion.

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Charles Bartell

Directs Mystik Research

Charles Bartell has been appointed director of research and development for Mystik Adhesive Products, Inc., Chicago, Ill. Mr. Bartell holds a Ph.D. degree from Ohio State University and was formerly a Research Fellow with Battelle Memorial Institute. A noted authority on polymer chemistry, with specilization in adhesives and pressure-sensitive tapes, Mr. Bartell had served with the Permacel Division of Johnson & Johnson. Prior to joining Mystik, he was an assistant to the director of research of the Dewey & Almy Chemical Division of W. R. Grace & Co.

Vinyl-Anchor Adhesive

Anchor Adhesives Corp., Flushing, N.Y.. has introduced Vinyl-Anchor adhesive, designed to bond under water, making it possible to adhere vinyl patches to large vinyl swimming pools without emptying the pool. Said to be resistant to oil and aromatic fuels as well as to water, Vinyl-Anchor is also suitable for adhering plastisols and organisols which contain a large amount of plasticizer and are usually difficult to adhere. The company states that in addition, it is possible to adhere vinyl sheet extrusions and molded plastisol parts, and to bond plastisol to metal, wood, glass and other materials. Once bonded, the manufacturer states, the adhesive will not soften due to plasticizer migration.

BRI Fall Conferences

Six topics make up the program for the 1961 Fall Conferences of the Building Research Institute, which will take place this year on November 28-30 at the Mayflower Hotel, Washington, D.C. The sessions will conclude with a roundup of widely varied aspects of building research which will offer reports on new research projects, results of recently completed projects, and reports on research in other fields that has importance for the building industry. Topics to be discussed are: "Prefinishing of Exterior Components," W. E. Kemp (Koppers Co.), chairman; "Performance of Plastics in Building," Donald R. Gray (Dow Chemical), chairman; "Mechanical Fasteners for Wood," Jack Godley (Gregory Industries), chairman; "Design for the Nuclear Age," Gifford H. Albright (Pennsylvania State University), chairman; "Identification of Colors for Building," Milo D. Folley (Sargent-Webster-Crenshaw & Folley), chairman; and "Methods of Building Cost Analysis," Charles Bogert (American Telephone & Telegraph), chairman.

Adhesive Council Meeting

The Rubber & Plastic Adhesive & Sealant Manufacturers Council will hold its Annual Meeting on November 15 to 17, 1961, at the Edgewater Beach Hotel in Chicago, Ill. The meeting will feature reports from the various Council committees, and new officers will be elected for the coming year.

Of special interest will be the kick-off of the Council's Public Relations Program. Through this program, the Council will publicize the advantages of belonging to the Association, and encourage the use of adhesives and sealants by fabricators and industry.

• Indco Lab, Santa Monica, Calif., has introduced a kit, consisting of skin conditioner, protective glove, water rinse hand cleaner and waterless skin cleanser, designed to prevent dermatitis, an occupational hazard.

T. P. Malinowski

Named by Staley

Theodore P. Malinowski has been named to head the recently expanded and reorganized chemical sales staff of the A. E. Staley Manufacturing Co., Decatur, Ill. Mr. Malinowski is a graduate of Brown University, with a B.S. degree in chemistry. He is credited with having played an important role in the development of plastic products for Monsanto Chemical Co. before joining Atlas Chemical Industries, Inc., first as assistant director of product development, and later as development manager. Prior to joining Staley, he served as industry marketing manager for Atlas' Chemical Division.

Avery Label Resists Cold

Avery Label Co., Monrovia, Calif., has developed a pressure-sensitive label designed to function efficiently at temperatures below 30° F. The new Perma-Grip label, which can be affixed either before or after freezing, is suggested for a broad range of products, including frozen foods, ice cream, dairy, drugs, chemicals and baked goods. The pressure-sensitive labels require no moistening or heat to make them adhere; they stick to most surfaces with simple fingertip pressure, and can be applied automatically, semi-automatically or manually. Other advantages claimed for the labels are speed of application, minimum adhesive deterioration, instant sticking and quality printing or embossing.

Norbert E. Talbert

Appointed by FMC

Norbert E. Talbert has been named as a market development representative for the Epoxy Department of FMC Corp., New York, N.Y. His new assignment includes responsibilities in the area of the firm's recently introduced Oxiron epoxy resins. Mr. Talbert graduated from the Polytechnic Institute of Brooklyn with a B.S. degree in chemistry. His background covers almost 20 years of development work in plastics, resins ,and pigments for such companies as Curtiss Wright Corp., Republic Aviation Corp., and Riechold Chemicals, Inc. Before assuming his new position, he was engaged in application studies of Oxiron resin cure systems and their relation, in particular, to casting uses, working at FMC's laboratories in Princeton, N.J. Mr. Talbert is a member of the American Chemical Society and the Society of Plastics Engineers.

Home Sealant Available

Polysulfide-base compounds are now available for small-scale sealing and caulking, having been introduced by Advance Polymer, Inc., Detroit, Mich. The simplified package contains a sealant based on polysulfide liquid polyer, manufactured by Thiokol Chemical Corp., Trenton, N.J. Applications for the sealant, trademarked Thiolastic, include the sealing of expansion joints, flashings, gutters, copings, glass and window bedding, floor cracks, pipe openings and others.

EXAGGERATED? Sure. But it does help make the point that phenolic neoprene adhesives are rapidly replacing conventional adhesives in metal-to-metal, cloth-to-metal bonds and for any combination of cloth, metal, glass, leather, or paper. These, and other types of structural fastening show one of the biggest growth areas in synthetic resin-based adhesives. But here, as in any other area, you have to use the right resins for the right jobs.

That's why it pays to deal with *Union Carbide*. We have the broadest line of synthetic resins for adhesives. And although we don't know everything about application and formulation, we have developed a great deal of pertinent information which may help you take better advantage of this growing field. Besides phenolics (we make over a dozen different phenolic resins for use in adhesives), we have a full line of vinyls *and* epoxies. Why not find out for yourself how BAKELITE resins can give you a head start in the adhesive fastening market? Write Dept. KX-1K, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

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names in the news

Theodore R. Hopper has been appointed to the staff of the application group in the Epoxy Department of FMC Corp., Princeton, N.J.

Henry J. Roux, formerly research chemist at the Armstrong Cork Co., has been named to the newly-created position of manager of technical sales services for the Building Products Division, Lancaster, Pa.

Edward J. Breza has been named assistant research chemist in the Research and Development Division of the Metal & Thermit Corp., Rahway, N.J.

Calvin L. Immel, formerly sales representative for the Archer-Daniels-Midland Co., Minneapolis, Minn., has been promoted to technical specialist in the Specialty Chemicals Department and has been transferred from Philadelphia, Penna. to Minneapolis.

Joseph W. Calby has been named manufacturing coordinator of the Plastics and Resins Division of the Enjay Chemical Co., New York, N.Y.

Sterling E. Brown, Jr., previously associated with Champion Paper & Fibre Co. and the Royal Paper Corp., has been appointed sales representative for upstate New York for the Atlantic Gummed Paper Corp.; he will be headquartered in Buffalo.

George Japp, formerly assistant to the plant manager of General Corrugated Machinery Co., Inc., Palisades Park, N.J., has been named representative for the northeastern states and Canada.

Arnold R. McCombs, production manager of building materials operations for the Armstrong Cork Co., Lancaster, Penna., has retired after 31 years of service with the company.

Raymond T. Heilpern, secretary and general counsel of U.S. Plywood Corp., New York, N.Y., has been elected a director of the company.

Eric Q. Bohlin, vice-president in charge of manufacturing for Eberhard Faber, Inc., has been elected executive vice-president.

Arthur Minich, formerly president of the Nuodex Products Division of the Heyden Newport Chemical Corp., New York, N.Y., has been appointed president of the company's Heyden Chemical Division.

Mathias W. Niewenhous, director of the Chemical, Agricultural and Forest Products Office of the Office of Civil and Defense Mobilization, has retired.

Ray L. Ash, formerly executive vice-president of Litton Industries, Inc., Los Angeles, Calif., has been named president, succeeding *Charles B. Thornton*, who will continue as chairman and chief executive officer.

Karl M. Bierman, formerly Eastern regional sales manager, has been appointed marketing staff manager of the Armour Industrial Chemical Co., Chicago, Ill.

Fred R. Loetscher, formerly general sales manager and a director of Farley and Loetscher Manufacturing Co., has joined the Formica Corp., Cincinnati, Ohio, as product manager, formica panels and doors.

C. Gordon Jelliffe, president of Columbus Coated Fabrics Co., Columbus, Ohio, has been named a vice-president of Borden Chemical Co., New York, N.Y.

Dr. William E. Thompson, formerly associated with the Southwest Research Institute, has been named director of research for the Archer-Daniels-Midland Co., Minneapolis, Minn.

Daniel E. Lucas

Named by Corn Products

Daniel E. Lucas has been appointed eastern regional sales-service manager for the Industrial Division of Corn Products Sales Co., New York, N.Y. He succeeds Clyde D. Woodburn, who was recently named manager of the Division's Philadelphia, Penna. district office. A graduate of St. Mary's College, Mr. Lucas has been a member of the Corn Products organization since 1947. He served in the Research Department before transferring to the Technical Servce Department. Hs most recent assignment was manager of this department in Argo, Ill.

Dr. Frank R. Jones has joined the Polychemicals Department, in the Research and Development Division of E. I. du Pont de Nemours & Co., Wilmington, Del.

James M. Jans has been promoted to chief engineer in the General Chemical Division of the Allied Chemical Corp., Camden, N.J.

Glenn Purcell, plant manager for Shell Chemical Corp., Houston, Tex., has retired after 32 years with the company.

Dave W. Schornstein has been named manager of organic chemicals sales at the Dow Chemical Co., Midland, Mich. He succeeds *Earl H. Farnham*, who has been transferred to the Chemicals Department of the company.

Borden Units Overseas

Borden Chemical Co., New York, N.Y., has begun operations at two new South American units, and has started a new building program in France and England. In Cali, Colombia, an addition to the existing facilities of Cia. Quimica Borden S.A. is designed to produce 6.6 million pounds of resins of the urea, phenolic and resorcinol types, and 13 million pounds of formaldehyde annually. In Pilar, Argentina, a plant addition to Cia. Casco S.A.I.C. is producing substantially the same products and quantities as the Colombian operation. A portion of the 70,000 square foot Pilar facility has been set aside for warehousing and future expansion. The new Latin American plants are operated under the direction of Borden Chemical's International Division. The products are being sold to the local plastics, textile, automotive, plywood, furniture, leather and construction industries.

The company has also scheduled a new thermosetting resins plant in Fecamp, France, called the Borden Chemical Company (France) S.A. It is to be completed late in 1961. Additions to resin production capacity and construction of a new formaldehyde plant at Borden's English subsidiary, Leicester, Lovell & Co., Ltd., are scheduled for completion in the last quarter of 1961 and early 1962, respectively, the company states.

Develops Isochemrez 444

Isochem Resins Co., Providence, R.I. has developed a low density, machinable, syntactic, foam-in-place resin series, designated Isochemrez 444. The system is based on a ceramic sphere that has been stabilized in the epoxy to give minimum air voids and top structural strength to the resin, according to the manufacturer. Isochemrez 444 does not separate in storage or in cure, the company states, and cures at room temperature overnight or at 100°C. for one hour, or both. The resin uses a long pot life hardener and a flexible low exotherm hardener to provide diversity in application. The series is suggested for use in electronic, missile or instrument sealing, potting or encapsulation fields.

Acquires Swiss Interests

Stein, Hall & Co., Inc., New York, N.Y., has acquired an important interest in Meypro AG, a major producer of natural gums and chemically treated derivatives, with plants in Kreuzlingen, Switzerland, Zaandam, Holland and subsidiaries in Holland and Germany. Stein-Hall also revealed that it is organizing a new chemical company in Switzerland for the sale products manufactured by Meypro AG, as well as certain chemical products manufactured by Stein, Hall.

Plans Research Center

The Chicago, Ill., division of the Kendall Co. is planning a new research center in Barrington, Ill., for work on industrial adhesives and plastics. The $1.5 million laboratory is scheduled for completion in the Fall of 1962.

• A new trademark, based on the symbolic design of the letter "M" and "A", and new package design have been selected for the Magibond line of adhesives of the Magichemical Co., Brockton, Mass.

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CIBA Represents Eporal

CIBA Products Corp., Fair Lawn, N.J., has been appointed exclusive sales agent for Eporal, a curing agent recommended for applications requiring long shelf life. Chemically, Eporal is known as diaminodiphenyl sulfone (DDS or DADPS); physically, it is a tan powder said to be almost completely odorless. Adhesives, pre-preg laminates, castings and tooling are listed as the chief end uses for the new product.

RMI Appoints Cohn

Jerome I. Cohn has been appointed director of sales engineering for Radiation Materials Inc., L.I.C., N.Y. Mr. Cohn holds a B.E.E. from the City College School of Technology. He was formerly head planning engineer at the New York Naval Shipyard, following which he joined the Electronic Wiring Corp. as manager of manufacturing. Most recently, he served as director of sales and marketing at INSO Electronic Products, Inc.

FMC Plans Expansion

FMC Corp., San Jose, Calif., has filed a registration statement with the Securities & Exchange Commission, in which the company proposes a public offering of $30 million worth of convertible, subordinated debentures due October 15, 1981. This would increase the firm's long-term debt by 51.6 per cent, to nearly $88.1 million, but its long-term debt would still be less than 30 per cent of total capitalization. Proceeds from the offering will be used for expansion, modernization and new facilities for the company's chemical, defense and machinery divisions and for additional working capital; it will also be used to pay off $4 million worth of sinking-fund debentures due next March 15. FMC revealed that it is planning to invest $25 million in new plant and equipment this year, and a like amount next year. Last year, its capital spending totaled $23.4 million, of which more than two-thirds was spent for chemical facilities.

For the first six months of this year, the preliminary prospectus reveals, total chemical sales of $91.45 million included $30.3 million from insecticides and other agricultural chemicals; $25.6 million from phosphates, barium and magnesium chemicals; $21.15 million from alkalis, chlorinated chemicals and carbon bisulfide; $7.6 million from plasticizers and organic and fine chemicals; and $6.8 million from peroxygen chemicals.

Formica Appoints Bryant

R. Bruce Bryant has been named district manager, located in the St. Louis, Mo. office, by Formica Corp., Cincinnati, Ohio. He succeeds Fred C. More, district manager in St. Louis since 1948, who will remain in the city with the company's Industrial Product Division. In his new post, Mr. Bryant will direct sales and service of adhesives, Formica decorative laminated plastics, Flakeboard, and commercial doors. A graduate of the University of Pittsburgh, Mr. Bryant has been with Formica since 1952, and was formerly sales representative in East Orange, N.J. with the firm's Industrial Product Division.

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	P-561	P-562	P-563				
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ADHESIVES GUIDE

by JOYCE HURD

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Nov. 7-10. Packaging Machinery Manufacturers Institute Show of 1961, Cobo Hall, Detroit, Mich.

Nov. 13-14. Society of Packaging & Handling Engineers, National Packaging & Materials Handling Competition, and 7th Annual Eastern Packaging & Handling Show, Fifth Regiment Armory Hall, Baltimore, Md.

Nov. 15-17. Rubber & Plastic Adhesive & Sealant Manufacturers Council, Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

Nov. 21. Manufacturing Chemists' Association, Semi-Annual Meeting, New York, N.Y.

Nov. 26-Dec. 1. American Society of Mechanical Engineers, Winter Annual Meeting, Statler Hilton Hotel, New York, N.Y.

Nov. 27-Dec. 1. Chemical Industries Exposition, N.Y. Coliseum, New York, N.Y.

Nov. 28-30. Building Research Institute, Fall Conferences, Mayflower Hotel, Washington, D.C.

Nov. 28-Dec. 1. Chemical Market Research Association, Mark Hopkins Hotel, San Francisco, Calif.

Dec. 4-6. Chemical Specialties Manufacturers Association, 48th Annual Meeting, Roosevelt Hotel, New York, N.Y.

Dec. 7. Synthetic Organic Chemical Manufacturers Association, Annual Meeting, Roosevelt Hotel, New York, N.Y.

Dec. 7-8. Society of the Plastics Industry, 9th Plastic Film, Sheeting & Coated Fabrics Conference, Pierre Hotel, New York, N.Y.

Dec. 26-31. American Association for the Advancement of Science, Chemistry Division Annual Meeting, Denver, Colo.

Jan. 25, 1962. National Fibre Can & Tube Association, Biltmore Hotel, New York, N.Y.

Jan. 30-Feb. 2, 1962. Society of Plastics Engineers, 18th Annual Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Penna.

Feb. 5-9, 1962. ASTM Committee Week, Statler Hilton Hotel, Dallas, Texas.

Feb. 6-8, 1962. Society of the Plastics Industry, 17th Reinforced Plastics Division Conference, Edgewater Beach Hotel, Chicago, Ill.

Feb. 18-22, 1962. TAPPI, 47th Annual Meeting, Commodore Hotel, New York, N.Y.

Mar. 6-8, 1962. Material Handling Institute, Pacific Coast Show, Pan Pacific Auditorium, Los Angeles, Calif.

Mar. 13-14, 1962. Manufacturing Chemists' Association, Symposium on Packaging of Chemical Products, Chase-Park Plaza Hotels, St. Louis, Mo.

Mar. 14-18, 1962. National Flexible Packaging Association, Spring Meeting, Boca Raton, Fla.

Mar. 20-29, 1962. American Chemical Society, 141st National Meeting, Washington, D.C.

Portrait of

FLOYD H. BAIR

Floyd H. Bair is a project engineer doing work on organic and inorganic structural adhesives, composite constructions, and reinforced plastics at the Aeronautical Systems Division, Directorate of Materials and Processes, Wright-Patterson Air Force Base, Ohio.

Mr. Bair studied at Indiana State College, Duke University, Pennsylvania State University, and Yale University. After teaching science subjects in high school, he became an instructor in maintenance engineering in Air Force technical schools at Chanute Field and Yale University. In 1945, he started research work in what is now the Bureau of Naval Weapons at the Naval Air Materiel Center, Philadelphia, Penna. At that time, structural adhesives for metals were first being developed.

Ever since his job with the Bureau of Naval Weapons, Mr. Bair has devoted himself to work in the adhesives field. He has served on ASTM's Committee D-14 on Adhesives since 1946, and has also done work on Committee C-19 on Structural Sandwich Construction. Mr. Bair is the author of numerous articles on adhesives. His article "Space Age Adhesives" appeared in the February, 1959, issue of ADHESIVES AGE.

FTC Orders Hooker To Sell Phenolic Assets

Hooker Chemical Co., New York, N.Y., has consented to an order by the Federal Trade Commission to divest itself of the phenolic molding materials production facilities which it had purchased from Monsanto Chemical Co., St. Louis, Mo. in 1958. The Commission, in making the announcement, also revealed that it is dismissing a further charge that Hooker violated the law by purchasing Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y. in 1955.

The FTC had filed a complaint in July, 1960, charging that acquisition of the Monsanto assets and the Durez company violate the anti-merger law because it might substantially lessen competition or tend to create a monopoly in the production and sale of phenolic molding materials and in the general purpose, electrical, impact, and heat resistant lines of these materials. The FTC complaint further charged that the purchase of the Monsanto facilities had increased Hooker's market share of all molding materials to about 56 per cent.

Under the consent agreement, Hooker is required to "divest itself absolutely" within ninety days of all machinery and equipment, all technical information, formulae, know-how, trade secrets and customer lists related to the production and sale of phenolic molding compound formulations. The purchaser of the Monsanto facilities may not be anyone directly or indirectly under the control of Hooker or any of its subsidiaries or affiliates. In addition, the FTC order forbids Hooker, for the next ten years, to acquire any shares of stocks or assets of any manufacturer or distributor of phenolic molding compounds in the United States.

The Commission dismissed its charges regarding the acquisition of Durez Plastics & Chemical after concluding that Hooker's entrance into the industry has not effected market structure, conduct or performance, and that Hooker's post-acquisition market share increase cannot be connected with the acquisition of Durez.

Shown during negotiations for the newly-formed Reichhold Chemicals India Private Ltd. in India are (l-r): Shri S. Anantharamakrishnan, chairman of the board, Amalgamations Private Ltd. and of the new firm; Dr. S. H. Bau, executive vice-president, Reichhold Chemicals, Inc.; and Shri P. L. Kumar, managing director of Simpson and Co. Ltd. and director of Amalgamations Private Ltd.

Reichhold Forms Indian Firm

Reichhold Chemicals, Inc., New York, N.Y., has signed an agreement with Simpson & Co. Ltd., subsidiary of Amalgamations Private Ltd. for the formation of a new firm in India, whose first venture will be the establishment of a chemical plant in Madras. The new company, to be known as Reichhold Chemicals India Private Ltd., will have an initial capitalization of two million rupees ($420,000), which will be used for building production facilities.

Total authorized capital for future expansion will amount to 10 million rupees ($2,100,000). At the outset, the new plant will produce synthetic resins for India's adhesives, surface coatings, textile and plastics industries; future expansion of facilities for the production of other RCI basic chemicals is contemplated. As part of its agreement with the new Indian company, Reichhold will supply engineering know-how and maintain a program of continuing technological advice and assistance. The agreement, permitting the establishment of the first chemical producing venture of Simpson, was signed by S. L. Singla, Under-Secretary of the India Ministry of Commerce and Industry.

PVA Prices Reduced

West coast prices of polyvinyl acetate emulsions have been reduced by 1½¢ according to the South San Francisco, Calif., office of Reichhold Chemicals, Inc. The new prices, which became effective August 28, 1961, bring West Coast quotations into line with East Coast prices. Reichhold has also announced that production of PVA emulsions will soon be started at two new West Coast locations — Azusa, Calif. and Tacoma, Wash.

Foil Adhesives Developed

Rubba, Inc., New York, N.Y., has developed a water-based adhesive for laminating aluminum foil to paper and plastics. Rubbatex Aluminum Foil Adhesive requires only one-side wet application to form a strong, permanently-flexible bond. When laminating foil to plastics and other non-porous surfaces, the adhesive is applied to one surface and allowed to dry. When dry, a permanent bond will be formed upon application of heat.

patent review

By MELVIN NORD

Hydrolysis of Starch

U. S. Patent 2,989,425, issued June 20, 1961 to Svante Bierke and Mihajlo Mautner, assigned to Aktiebolaget Separator, provides a method for the hydrolysis of starch in acid water suspension while heating.

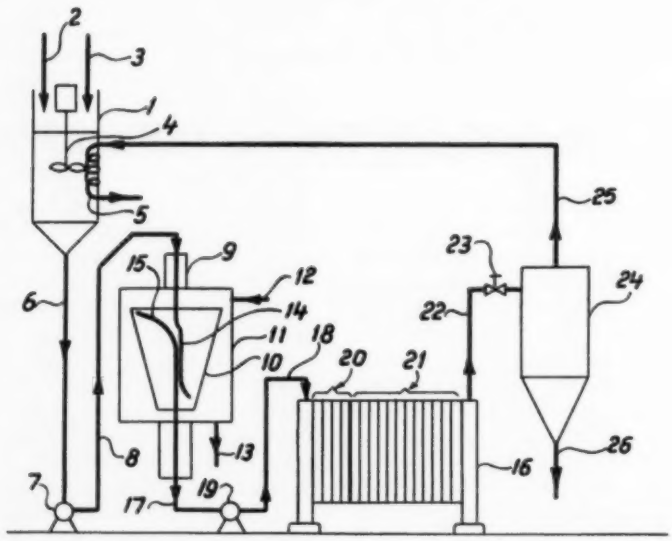


Figure 1

In Figure 1, (1) denotes a container into which are led a starch suspension of 22° Bé. and hydrochloric acid through pipes (2) and (3), respectively. The suspension is acidified by a suitable dosage of the acid, to a pH-value of 1.7. In the container are arranged a motor-driven stirrer (4) and a pipe coil (5), which is heated by steam. The pipe coil heats the suspension to 40° to 50° C.

From the bottom of the container, the starch suspension is discharged through a pipe (6) to a pump (7) which feeds the suspension through a pipe (8) into a heater (9). The latter is an externally-heated hollow rotor (10) having conventional means for mounting and driving it on a vertical axis, the rotor having an imperforate wall frusto-conical shape tapering downward.

The rotor is located in a housing (11) to which steam is supplied through a pipe (12), condensed water being discharged through an outlet (13). The condensed water is formed by the condensation of steam on the outside of the rotor (10). The suspension is led into the heater (9), at the narrow end of the rotor (10), by means of a stationary pipe (14), and is pared out from the wide end of the rotor by means of a stationary paring tube (15). The time during which the suspension remains in the rotor is ½ to one second., and in that time the suspension is heated to 95° C. Because of the rapid heating to this temperature, the gelatinization temperature is also passed rapidly (the latter is between about 63° to 68° C. according to the type of starch). This avoids a detrimental formation of gelatinized starch which clogs apparatus and piping.

As will be seen from the drawing, the rotor is conical. Owing to the introduction and discharge shown, a thin film flowing rapidly from one end of the rotor to the other, is formed. In producing, for example, crystallizable glucose, the starch solution is treated further in a plate heat exchanger (16) into which it is fed by a pump (19) through pipes (17) and (18). In section (20) of the plate heat exchanger, the starch solution is brought to a temperature of 130° to 150° C. and is maintained at this temperature in the other and larger section (21) of the plate heat exchanger. In the latter section, where the holding time is two to 15 minutes, according to the product desired, a hydraulic pressure is maintained—for example, of ½ atm. above the prevailing steam pressure, to prevent steam generation. The solution leaves the heat exchanger (16) through a pipe (22) having a pressure reducing valve (23) and passes to an expansion vessel (24) where, due to the pressure drop, steam is boiled off. The steam boiled off can be fed via a pipe (25) to the pipe coil (5), to be used there for pre-heating the starch suspension. The ready hydrolyzed product is discharged through a pipe (26) and neutralized, as with a solution of sodium carbonate. This can be done continuously and automatically. The product is then passed further on for purification, evaporation and crystallization.

The rotor (10) can be open or closed to the atmosphere, but is preferably closed to the steam chamber in housing (11).

Adhesives Compositions

U. S. Patent 2,986,546, issued May 30, 1961 to Marguerite Naps and assigned to Shell Oil Company, provides an adhesive composition consisting of a glycidyl polyether of a polyhydric phenol, a methylol-containing phenol-aldehyde resin, and a polyvinyl acetal resin of an alkanol of 1-4 carbon atoms.

Natural to Butyl Rubber

U.S. Patent 2,992,962, issued July 18, 1961 to James B. Borland and Harvey J. Batts, assigned to United States Rubber Co., provides a method of adhering brominated solid, plastic, rubbery, olefinically-unsaturated interpolymer (a major proportion being an isoolefin having 4-8 carbon atoms per molecule, and a minor proportion having 4-18 carbon atoms per molecule), to natural rubber.

The method consists of incorporating in the natural rubber a mixture of hydrated clay, zinc oxide, and depolymerized rubber, applying the brominated interpolymer to the natural rubber composition, and vulcanizing the resulting assembly.

Adhesive Paper Tape

U.S. Patent 2,992,129, issued July 11, 1961, to Armand J. Gauthier and assigned to Ludlow Corp., provides an adhesive paper tape. The tape consists of a flexible paper tape body, a layer of gum material capable of being rendered adhesive on contact of liquid water on one surface of the tape body, and discrete ink indicia deposited interruptedly along the length of the tape in staggered fashion so as to span the width of the tape. The ink indicia consist of thin layers of ink comprising a mixture of a surfactant (for reducing the surface tension of the water applied to the gum layer), and a toxicant (for conditioning the water applying device).

Bonded Glass Fiber

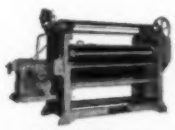
U.S. Patent 2,990,307, issued June 27, 1961 to Joseph P. Stalego and assigned to Owens-Corning Fiberglas Corp., provides a binder composition for use in the manufacture of thermally stable bonded glass fiber structures.

The binder is an aqueous system containing binder solids composed of 5-50 per cent by weight of phenol-formaldehyde resin in a water soluble stage, 3-35 per cent by weight of a melamine formaldehyde resin, 5-50 per cent by weight of an alkyd resin, 5-60 per cent by weight of urea borate, 1-10 per cent by weight of an oleaginous lubricant, and 0.04-3% per cent by weight of an organo silicon fluid.

Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Gluing apparatus	Ivan A. Williams	2,989,940	6/27/61
Application of tape to moving objects	Minnesota Mining & Manufacturing Co.	2,990,081	6/27/61
Bonding of polyethylene terephthalate fibers to rubber	Imperial Chemical Ind., Ltd.	2,990,313	6/27/61
Cement manufacture	Texaco Development Corp.	2,991,062	7/ 4/61
Adhesive composition	Shell Oil Company	2,991,258	7/ 4/61
Adhesive applying apparatus	American Machine & Foundry Company	2,991,753	7/11/61

Copies of any patents, including those described here, are available from the Commissioner of Patents, Washington 25, D.C., for 25 cents each. Do not send stamps.


22-D Roller Coater Bulletin 11-A, Part 6

ROLLER COATERS: Single or double coaters, 8" through 122" roll widths, for application of various finishes and coatings to flat surfaces. Also TOP Reverse Roll Filling Machines.

Reverse Roll Filling Machine Bulletin 11-A, Part 6S

2-8" Bench Type Spreader Bulletin 11-A, Part 1

No. 567 Spreader Bulletin 11-A, Part 2

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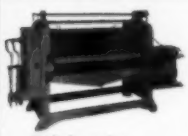
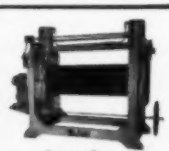

22-D Spreader Bulletin 11-A, Part 4

Air Hose Laminating Press Bulletin 11-D

Motorized Laminating Press Bulletin 11-E

COLD PRESSES: A wide line of high-production presses: Rotary-type; Air-Hose; Electric, Hydraulic and Hand Power Laminating Presses.


Rotary Press Bulletin 11-C

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Portable Glue Mixer Bulletin 11-IS

Sash, Frame and Door Clamp Bulletin 11-M

Clamp Carrier Bulletin 11-K

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Case Clamp Bulletin 11-J

new equipment

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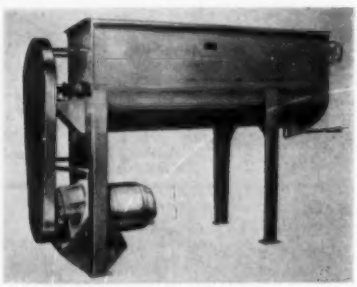


cess covers with mechanical, sliding, folding, bolted, or hinged panels; adjustable, elliptical orifice knife gates for accurate flow rates and minimum dead pockets areas; and wide foot legs for greater stability. Capacities of the Super-Mix line range from 13 to 250 cubic feet in carbon or stainless steel construction. *Superweld Corp.* **E-366**

Automatic Checkweigher

Model 1205-S, a new type of Selectrol automatic, high-speed checkweigher, is specially designed for installations where floor space is at a premium. Over-all dimensions are 20″ deep and 22″ long, with an adjustable height of 35 to 40″. According to the manufacturer, the checkweigher will automatically weigh, classify, and separate packages by correct weight, over weight, and under weight, at speeds up to 200 per minute depending on the accuracy requirements and product handling characteristics. Standard models will weigh packages in a range up to 12 ounces. *Exact Weight Scale Co.* **E-367**

Automatic Variable Imprinter

This variable imprinter, capable of making 8,000 impressions an hour, is designed to print pressure-sensitive labels as required, automatically, from type, rubber plates or slugs. Engineered to print pressure-sensitive label sizes from 7/16-inch by 1-9/16 inches to 4½ by 4¾-inches, the unit features an automatic rewind unit and a five-roller inking system. The imprinter is ideal for in-plant use, according to the manufacturer, since it imprints code numbers, dates, carton contents, sizes, batch numbers, ingredients, part numbers, electrical data and prices, as well as other kinds of variable data. In addition, it imprints all popular label materials, including foil, fabric, paper and other types of stock. *Avery Label Co.* **E-368**

Electrically Heated Platens

Electrically heated platens used for attaching labels having heat sensitive adhesives employ an exclusive multiple circuit, blanket-type heating element which allows heat to be applied either uniformly or in varying watt densities. In addition, by varying of element location, "hot spots" can be created or eliminated, depending on functional requirements of the unit. Maximum voltage is determined by platen size and configuration. *Sta-Warm Electric Co.* **E-369**

Small Spray Gun

Ideal for applications where space is a problem, Model 2277 is an automatic spray gun only 3″ long. Said to be the smallest gun available, it features a stainless steel body, needle, and fluid nozzle; 1/8″ air and liquid connections; set-screw in cap for needle adjustment; and a wide selection of nozzle combinations. *Spray Engineering Co.* **E-370**

Automatic Flow-Curve Recorder

Designed to provide a rapid, standardized testing procedure for non-Newtonian fluids is the Automatic Flow-Curve Recorder. It exhibits shear-dependent and time-dependent flow behavior by eliminating operator error. A complete shear stress/shear rate curve can be plotted in as little as 10 seconds.

Combined with the ease of cleaning and loading, for which the instrument is already noted, the unit permits a very high production rate possibility. Any one of eight acceleration rates may be selected giving times to maximum speed from 10 to 600 seconds. A fast up/down facility is also provided which gives full speed in about one second where it is desired to minimize the duration of shear in reading a desired shear rate. The Flow-Curve Recorder unit is designed to fit beneath the existing Viscometer Indicator Unit. *Ferranti Electric Inc.* **E-371**

Airless Spray Unit

The Balcrank E-HY 50 electrically operated airless unit is designed for spraying without the use of an air compressor to supply air for operating the unit or for atomization, as well as without the use of heat. The unit has a universal explosion-proof motor that operates both the pump and a built-in agitator. Instant fluid pressure is provided at the spray gun as soon as the motor is started. There is no air or fluid pressure on the material container which has a five-gallon capacity. Fluid pressures range from 1500 to 2200 psi. A conventional airless gun with a tungsten carbide tip is used, and the unit is supplied with 25 feet of 1/4″ hp nylon plastic covered hose. *S & S Engineering Co.* **E-372**

Sealant Tester

The Sika dynamic tester is used to evaluate the many new sealants and mistics used in heavy construction, building construction, road work, bridge work, etc. The machine makes extension tests, compression tests, variable rate of load applications, force necessary for extension and compression, tests for maximum extension, fatigue failure,

and environmental testing. According to the company, it has been found particularly useful for new elastomeric sealants with their increased capabilities for sealing joints, concrete, and other materials. The testing machine comes complete with power source, chain drive, gear reducing system, driving screws, loading heads, recording devices, and a carrying frame. Six samples can be tested simultaneously at either low or elevated temperatures. *Testing Machines, Inc.* **E-373**

Portable Blow Tank

A pneumatic conveying system, the portable blow tank is designed for handling PVC resins and other dry plastics and chemicals. The new design features a minimum of moving parts in the product zone, elimination of the inlet rotary feeder normally used in positive pressure pneumatic systems, compactness, simplicity, and portability for cycling and batching operations. *Young Machinery Corp.* **E-374**

Resin Dispenser

Designed for dispensing reactive resins and hardeners the Turvort gun weighs less than one pound. The gun, when fed from a metering system mixes and dispenses reactive resins and, when equipped with proper spray tips, can do airless spraying of multicomponent resins materials. The unique design of the head eliminates the need for solvent purging and the trigger action of the gun handle permits spraying as conveniently as conventional spray equipment. The gun handles urethane foam resin materials, liquid epoxy resins, liquid polyester resins and many other materials when equipped with an appropriate metering system to supply materials in the proper proportions. *Leal Corp.* **E-375**

Mixer and Disperser

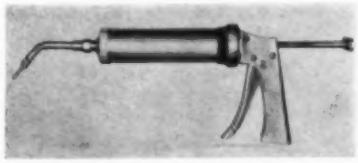
Operating on the principle of vortical mixing with extremely high shear rates, the Prodex-Henschel mixer is designed for intensive dry-blending and thorough dispersion of resins, powders, and flake with other powders, pigments, or liquids. The mixer can be operated automatically and be fed through a charging hatch directly from a bin through a weigh feeder. Liquids and other additives can be introduced while the mixer is running, and the unit can be discharged within 5 to 10 seconds through an air actuated discharge flap. The mixer comes in 4 sizes, from 0.37 to 17.5 cu. ft. *Prodex Corp.* **E-376**

Automatic Case Set Up

Called the Sysco II, this automatic case set up, loading, and sealing machine is said to be capable of handling various sizes of corrugated containers for many industrial and consumer products. The unit can easily be adjusted to handle various sizes of end-loaded cases, and operating speed is up to 10 cases per minute. The machine, with its case set up, loading and sealing unit, can be adjusted to handle various sizes of corrugated containers and to load nearly any products packaged in fibre boxes, overwrapped multi-packs, and paperboard boxes. *Systemation Corp.* **E-377**

Needle-Nose Sealer Gun

A needle-nose sealer gun for pressure application of adhesive and elastic compounds expressly created for marine use features a 4-inch curved nose assembly with a ¾-inch long nozzle. A 1/16-inch orifice in the nozzle permits pressure application of the sealer into the hair-line



seams encountered with clinker or lapstreak hull construction. The gun permits the operator to force compound into the seams which previously could only be surface-applied and wiped in. The gun can also be used for conventional caulking of planked hulls, as the gun tip can be inserted directly into the seam. This permits a caulked joint to be made from inside the seam, eliminating the possibility of voids and pockets. *Vital Products Manufacturing Co.* **E-378**

Panel Gluing Machine

Designed to provide efficient panel production for the mass-produced case goods industry, the Shuttle-Type Panel on-Frame Press is designed for maximum production with a two to three man crew.

The press has produced 1000 to 2000 panels in an eight hour shift, depending upon panel size and construction. This new type of bonding machine is said to reduce the inherent inefficiencies of cold presses, *Industron Corp.* **E-379**

FOR MORE INFORMATION on these new products use the Readers' Service Coupon on page 54.

book reviews

The Science of Adhesive Joints. ***By J. J. Bikerman. Published by Academic Press, 111 Fifth Ave., New York 3, N.Y. 5½ x 8¼ in. 258 pp. $8.00.***

As a summary work, this volume would do credit to any field. That Mr. Bikerman has chosen to devote his energy to dissecting the large body of tradition surrounding adhesive technology and to develop a systematic presentation of the nature of the adhesive joint should earn him the thanks of the whole industry.

Two themes are encompassed in this book. On the one hand, it includes a systematic analysis of the various factors that actually comprise an adhesive joint, a term that the author has shortened to *adhit*. This analysis is scientific, thoroughly documented, and a comprehensive summary of the best of current thinking. In many cases, for instance, the author will include the mathematical derivation of a formula or conclusion. Charts, tables, and drawings are used to clarify or substantiate given points.

On the other hand, however, Mr. Bikerman has been able to fashion a book that should be of considerable value to the practical-minded technician working on the solution to a given problem. For this analysis, which is summarized in the final chapter, makes it possible to systematically eliminate possible trouble spots until the causal one is found.

The major portion of the volume, however, is devoted to analysis of the adhesive joint. (One of the reasons for the use of the word "Science" in the title, the author states in his preface, is so that potential readers will not expect ready-made formulations for producing adhesives, or adhesive joints.) And in this the author has stated his own bias at the beginning.

He believes that when a joint is weak and breaks in apparent adhesion, a weak boundary layer is likely to be present; that is, a weakness is present, rather than strength is absent.

The initial chapter is an essay on solid surfaces, and in it the author has described the nature of surfaces as they pertain to adhesive joints. The second chapter on adhesive and other types of joints is an attempt to define precisely the true adhesive joint. Chapter 3, on the formation of the adhesive joint, is based on the reasoning in Chapter 2 and presumes that the adhesive joint is comprised of: (1) the two adherends; (2) the two surface-most layers of these adherends (which are usually contaminated by air, oxides, etc., and which the author calls the boundary layers); and (3) the adhesive film.

In the formation of the adhesive joint, wetting, measurement of contact angles, hysteresis of wetting, rate of wetting and removal of air, and pretreatment of adherend surfaces are discussed.

Chapters 4 and 5 discuss, respectively, tack and the setting stage. The sixth chapter, on the final strength of the adhesive joint, begins with a rebuttal to the idea that failures ever occur exactly along the adherend-adhesive interface. This rebuttal, based on probability theory, leads directly to the author's own hypothesis that the breaking stress of a true adhesive joint is related to the strength of the weakest phase of one of the materials, and not to a lack of adherence between two different materials.

Chapter 7, on stresses in adhesive joints, is organized according to the type of joint and the external action on it. Sub-divisions cover butt joints, lap joints, and peeling. The final chapters discuss the experimental strength of adhesive joints, tests, and the "Summary for the Practical Man," referred to previously.

The organization of this volume is exceptionally clear, coupling a well thought-out sequence of presentation with the leanness of good scientific writing. As a summary of the available scientific knowledge of adhesive joints it may well become a standard work.

The author is supervisor of the Adhesives Laboratory at the Massachusetts Institute of Technology, and is also a professor in the Department of Civil & Sanitary Engineering.

Adhesion to Board Manual. ***Prepared and published by the Packaging Institute, 342 Madison Ave., New York 17, N.Y. 8½ x 11 in., soft bound. 41 pp. $5.00.***

This manual deals with the practical problems that arise in paper board adhesion in the packaging industry. Its purpose is to summarize the vast amount of information that has been made available with the increasing variety of adhesives and boards on the market. The compilers were members of a committee composed of manufacturers and users of adhesives, paperboard and packaging machinery and in this work they have outlined the types, properties, handling and storage problems, and testing of both adhesives and boards.

The initial section on adhesives covers adhesion, basic classes of adhesives, handling, storage, preparation and dilution of adhesives, adhesive problems, and testing methods. While much of this material is not original and is available in other separate sources, its value here is the convenience and ease with which it may be referred to. The segment on properties, for instance, is in the form of a chart contributed by National Starch and Chemical Corp.

Section 2 is a five-page outline of the types of folding boxboard, properties affecting adhesion, storage and board problems.

For the company working in this area of manufacture, this manual should be a useful working tool.

Trade Literature

PAPER HONEYCOMB. This eight-page brochure describes paper-honeycomb, what it is, and what it can do. The publication describes how paper honeycomb meets the requirements of fabricators of industrial and commercial structures, floor and roof panels, partitions, doors, tables and packaging components. Paper honeycomb is manufactured from plain or resin-impregnated Kraft paper. It is made up of a series of hexagonal cells nested together to form panels of various sizes. The brochure also points out the versatility, insulating efficiency, fire resistant, and durable qualities of the product. In the closing pages a detailed graph explains how paper honeycomb can be expanded. Panels that can be expanded by hand and by mechanical means are both available. *Hexcel Products, Inc.* **L-424**

SAWTOOTH CRUSHER. This case history article, Bulletin CP-3, describes the use of a sawtooth crusher for the reclaiming of reject vinyl-asbestos tile and asphalt tile at the B. F. Goodrich Footwear & Flooring Co. The brief, illustrated article describes the feeding of various sized pieces into the whirling carbide-tipped saws of a heavy duty crusher at the rate of several thousand pounds per hour. Details on saw thickness, drives, material sizes, etc. are included. *Young Machinery Co., Inc.* **L-425**

TY PLY ADHESIVES. This technical data chart details the properties, usages and application techniques of TY PLY rubber-to-metal adhesives. The chart is designed to keep handy for quick reference whether for specifying the grade best suited for rubber bonding problems or for in-plant bonding process recommendations. *Marbon Chemical.* **L-426**

TECHNOLOGY OF ADHESIVES AT YOUR FINGERTIPS

a SERVICE

Subscribers to ADHESIVES AGE may now obtain, from one central source, technical literature dealing with all aspects of the adhesives industry. One or more of the books listed here may be of invaluable assistance to you. Look this list over and check the books suited to your needs.

- **Adhesive Bonding of Reinforced Plastics—H. A. Perry. $8.75.** Survey of the design and assembly of structures and products, particularly glass-fiber-reinforced plastic products, by means of adhesives. Gives data on equipment and methods used to produce adhesive bonded joints. ☐

- **Adhesive Bonding of Metals—G. Epstein. $2.95.** Considers adhesives used with metals, indicating when an adhesive-bonded joint is advantageous; the type adhesive to use; how to use it, and how to design the joint for optimum performance. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice—A. X. Schmidt and C. A. Marlies. $14.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research—G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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Trade Literature (Cont'd.)

HODAG SILICONE ANTIFOAMS. This eight-page, illustrated booklet tells how hundreds of industrial foaming problems may be solved economically with the application of silicone antifoam agents. The brochure also details the suitability of these Food and Drug Administration sanctioned antifoams in food processing and packaging. Prescribed levels for their use are given in comprehensive tables of properties. The data tabulated is useful in the selection and application of these silicone antifoams to foam problems encountered in both aqueous and non-aqueous systems. *Hodag Chemical Corp.* **L-427**

ALKYLATED PHENOLS. Bulletin T-205 describes general physical and chemical properties, structural formulas, and major uses and applications for four alkylated phenols: para-tertiary-butylphenol (PTBP); para-tertiary-amylphenol (PTAP); 2, 4-di-tertiary-amylphenol; and 2, 4-di-tertiary-butylphenol. Infrared absorption spectra are reproduced for both PTBP and PTAP. The bulletin also describes a typical resin reaction from the mixing of reactants to the end product. *Koppers Co., Inc.* **L-428**

PROPERTIES AND USES OF GELVA. Divided into four complete sections, this 40-page manual contains detailed specifications and physical characteristics of all homopolymer and copolymer resins, emulsions, solutions and spray-dried powders. The manual also provides data on the products' applications in building products, paints, paper and textile coatings, adhesives and others. Additionally, the manual contains formulations for selected applications which illustrate the versatility of polyvinyl acetate products. *Shawinigan Resins Corp.* **L-429**

VALCHEM PRODUCTS. A new booklet, Bulletin 61, indexes the approximately seventy-five products currently offered to the trade. All products are classified by end usage and each is briefly described. *Valchem.* **L-430**

FOR MORE INFORMATION on the literature items described here, use the Readers' Service Coupon on page 54.

DOUBLE BEAM RECORDING SPECTROPHOTOMETER. This illustrated brochure describes the Model 202 Spectrophotometer, a new, low-cost instrument operating in the ultraviolet and visible region of the electromagnetic spectrum. The instrument covers the 190 to 390 millimicron region in the ultraviolet, and the 350 to 750 millimicron region in the visible. The eight-page brochure describes the operating features of the instrument, as well as its performance, sampling accessories and specifications. *Perkin-Elmer Corp.* **L-431**

DIFFICULT ADHESIVE PROBLEMS. According to this 12-page booklet, the adhesives industry has some 36,000 problems annually. The booklet describes many solutions to the problems that exist in addition to listing many new adhesives, coatings and chemical compounds. There is also a two page section of the pamphlet devoted to a glimpse at how the industry began and what a top executive in the field thinks about it. *Adhesive Products Corp.* **L-432**

NEOVAC PLASTIC STARCHES. Bulletin T-8 is a 10-page brochure which gives complete information on NeoVac V21C plastic starch for use in conventional-type packages, and NeoVac V21P for aerosol packaging. *Polyvinyl Chemicals, Incorporated.* **L-433**

Adhesive Bonding of Reinforced Plastics

HENRY ALEXANDER PERRY

Consultant on Non-metallic Materials
Naval Ordnance Laboratory
White Oak, Maryland

Survey of the design and assembly of structures and products, particularly glass-fiber-reinforced plastic products, by means of adhesives. Gives data on equipment and methods used to produce adhesive bonded joints.

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in passing

Soaring Swedes

We are indebted to our friends at the Chemical Market & Research Co. who point out that the Swedish plastics industry is producing at an annual rate near 145 million pounds, with imports steadily rising along with production. Plastics imports increased from 32 million pounds in 1955 to 92 million in 1960. PVC is the most important resin produced, while polyethylene has been entriely imported in the past, predominantly from the United States. The Swedish chemical industry meets 75 per cent of its country's over-all needs and typical of a world-wide trend, it is becoming more self-sufficient.

By the end of 1963 it will be producing its own polyethylene and polypropylene. The latter will be produced by Svenska Esso which has a petrochemical cracking plant at Stenungsund to supply propylene. Montecatini is licensing polyproplylene manufacturing and selling rights. Other important Swedish chemical firms include Superfosfat Fabriks A.B. also called Fosfatbolaget, producer of a number of organics and inorganics, but not superphosphate; A.B. Forerade Superfosfatfabriker; Svenska Attikfabriken A.B., producer of polyvinyl acetate, acetic acid, formaldehyde and pentaerythritol; and Uddeholms Aktiebolag.

There are many other important suppliers. Today there are about 1200 plastics suppliers compared to 200 in 1945. The Svenska Plastforeningen, Stockholm, is the industry's association responsible for keeping these suppliers and their associates advised. A unique characteristic of the Swedish chemical industry, including plastics, is the high degree of integration with other industries, especially mining and paper.

Approximate tonnages of resin currently produced per year, based on Swedish Plastics Federation figures for 1959 and 1960, for thermosetting resins (millions of pounds) are: phenolics (7), urea and melamine (14) unsaturated polyesters (4). The greatest production of plastics in Sweden is in thermoplastics, especially vinyls (35) and styrene resins (8). Great Britain, West Germany and the United States supply Sweden with its import requirements for plastics. Resins not already mentioned which are imported into Sweden include silicones, epoxies, most cellulosics, halogenated specialty resins such as fluoropolymers, polyamides, polycarbonates, acetals.

Primary plastics and resin products are phenolic and amino adhesives for plywood and particle board for the furniture and building industries; reinforced laminates, recently covered under new building construction codes in Sweden for flame resistance; calendered PVC, cellulose and styrene films and sheetings; polyethylene and PVC pipe as well as wire and cable covering; polyvinyl chloride flooring amounting to about 20 million pounds production; foamed polystyrene, urethane, polyvinyl chloride and imported foamed-in-place urea-formaldehyde for building construction applications.

More Definitions

The Kleen-stik house organ, *Stickin' Around*, offers these now definitions:

Reliable Source: The guy you just met.

Informed Source: The guy who told the guy you just met.

Unimpeachable Source: The guy who started the rumor originally.

Coordinator: Man at desk between two expediters.

A Clarification: To fill in the background with so many details that the foreground goes underground.

A Program: Any assignment that can't be completed with one phone call.

To Activate: Add more names to the memo and make carbons.

To Implement A Program: Hire more people and expand the office.

A Meeting: A mass mulling by master-minds.

A Conference: Conversation is substituted for the dreariness of labor and the loneliness of thought.

To Negotiate: To seek a meeting of minds without knocking together of heads.

Re-Orientation: Getting used to working again.

Five Gallons and a Gal

A Miami service station has introduced a new gimmick for attracting trade. With every five gallons of gas, the customer may have — absolutely free of charge — a perfectly legal marriage ceremony performed by the station's mechanic. "I'm a notary public," the latter explains. "I also do welding jobs."

The first ceremony performed at the station cost the bridegroom $1.50 — for gas.